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25th BATCH

COMPUTER AND COMMUNICATION ENGINEERING

International Islamic University Chittagong

COURSE CODE: CCE-2407

COURSE TITLE: Basic Communication

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Bandwidth Of Amp! Modulation

The bandwidth of the signal can be obtained by taking the difference between the highest and lowest frequencies of the signal. From the above figure, we can obtain the bandwidth of AM wave as,

$$BW = F_{USB} - F_{LSB}$$

$$= (F_c + F_m) - (F_c - F_m)$$

$$\therefore \boxed{BW = 2F_m}$$

F_{USB} = Upper Side Band Frequency
F_{LSB} = Lower Side of band Frequency
(Message signal এর যে Frequency থাকবে তার দ্বিগুণ Frequency লাগবে)

Thus, it can be said that the bandwidth required for amp. modulated wave is twice the frequency of modulating signal.

Power Calculation of AM wave :-

$$AM(t) = \underbrace{A_c \sin 2\pi F_c t}_{\text{Carrier Frequency}} + \frac{mA_c}{2} \cos 2\pi (F_c - F_m)t - \frac{mA_c}{2} \cos 2\pi (F_c + F_m)t$$

তাহলে $P_t = P_c + P_{USB} + P_{LSB}$

we know that the standard formula for power of cos signal is,

$$P = \frac{V_{rms}^2}{R} = \frac{(V_m/\sqrt{2})^2}{2}$$

V_{rms} = is the rms value of cos signal
V_m = is the peak value of cos signal

(3 প্রকার পাব)

Carrier power,

$$P_c = \frac{(A_c/\sqrt{2})^2}{R} = \frac{A_c^2}{2R}$$

Upper Sideband power,

$$P_{USB} = \frac{(A_c\mu/2\sqrt{2})^2}{R} = \frac{A_c^2\mu^2}{8R}$$

Similarly, we will get lower sideband power same as that of the upper side band power,

$$P_{LSB} = \frac{A_c^2\mu^2}{8R}$$

Let's add three powers in order to get the ~~lower~~ power of AM wave,

$$P_t = \frac{A_c^2}{2R} + \frac{A_c^2\mu^2}{8R} + \frac{A_c^2\mu^2}{8R}$$

$$\therefore P_t = \left(\frac{A_c^2}{2R}\right)\left(1 + \frac{\mu^2}{4} + \frac{\mu^2}{4}\right)$$

$$\therefore P_t = P_c\left(1 + \frac{\mu^2}{2}\right)$$

(*) We can use this to calculate AM wave when the carrier power & the modulation index are known.

if Modulation index $\mu = 1$ $\mu = 1$ then the power of AM wave is equal to 1·5 times the carrier power.

The power required for transmitting an AM wave is 1·5 times the carrier power for a perfect modulation.

Current Calculation

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

Or, $$\frac{P_t}{P_c} = 1 + \frac{m^2}{2}$$

Or, $$\frac{I_t^2 R}{I_c^2 R} = 1 + \frac{m^2}{2}$$

Or, $$\frac{I_t}{I_c} = \sqrt{1 + \frac{m^2}{2}}$$

Or, $$I_t = I_c \sqrt{1 + \frac{m^2}{2}}$$

If we consider $m = 1$; for 100% modulation

$$I_t = I_c \sqrt{1.5}$$

$$I_t = 1.22\, I_c$$

∴

Transmitted Efficiency:-

Transmission Efficiency is defined as the ratio of total side band power to the total transmitted power.

$$\eta = \frac{P_{SB}}{P_t}$$

Or,
$$\eta = \frac{\frac{m^2 P_c}{2}}{P_c\left(1+\frac{m^2}{2}\right)}$$

$$= \frac{\frac{m^2}{2}}{\frac{m^2+2}{2}}$$

$$= \frac{m^2}{m^2+2}$$

$$\therefore \eta = \frac{m^2}{m^2+2}$$

Advantages of Amplitude Modulation:-

⇒ **Few Components Needed:-**

At the receiver side, the original signal is extracted (demodulated) using a circuit consisting of very few components.

→ Amplitude Modulation is very cheam. So the AM transmitter & AM receiver build at low cost.

→ It is simple to Implement.

→ Long distance Communication:-

Amplitude Modulated waves can travel a longer distance.

Disadvantages OF AM:

→ In AM most OF the power is Concentrated in the Carrier signal which contains no information. At the receiver side, the power consumed by the Carrier wave is wasted.

→ Requires high bandwidth:-

The amplitude modulation is not efficient in terms OF its use OF bandwidth. It requires a bandwidth equal to twice that OF the highest audio signal Frequency.

→ This type of transmission can be easily affected by the external radiation.

→ It is also affected by the man-made noises or radiations like waves from other antennas or channels.

→ AM can't be used for transmitting music as done by Frequency Modulation (FM).

→ AM can't be used for transmission of sensitive information like in the army, where interpretation or loss or disruption during transmission is not an option.

Applications of AM

→ **Air Band Radio:-**

Aerospace Industry. The VHF (very High Frequency) transmission made by the airborne equipment still use amplitude modulation. The radio contact between ground to ground & also ground to air use amplitude modulated ~~sto~~ (AM) signals.

Broadcast Transmission:-

AM is still ~~as~~ widely used for broadcasting either short or medium or Long wave bands.

Quadrature Amplitude Modulation:-

AM is used in the transmission of data of almost everything, from short-range transmission such as wifi to cellular Communications. Quadrature Amplitude Modulation is formed by mixing two carriers that are out of phas by 90°.

Single Sideband:-

AM in the form of single sideband is still used for HF (High Frequency) radio links.

Q1|

Assume $m(t) = A_m \sin \omega_m t$ and

$c(t) = A_c \sin \omega_c t$

Derive expression for amplitude Modulated (AM) wave AM(t)

~~Answ~~

Answer:-

$$A_c \sin \omega_c t + \frac{A_c m_a}{2} \cos 2\pi (F_c - F_m) t - \frac{A_c m_a}{2} \cos 2\pi (F_c + F_m) t$$

Q2| Assume $m(t) = A_m \sin \omega_m t$ and $c(t) = A_c \cos \omega_c t$ derive expression for amplitude modulated (AM) wave AM(t).

Answer:-

$$A_c \cos \omega_c t + \frac{A_c m_a}{2} \sin 2\pi (F_c - F_m) t - \frac{A_c m_a}{2} \sin 2\pi (F_c + F_m) t$$

Q3| Assume $m(t) = A_m \cos \omega_m t$ &

$c(t) = A_c \sin \omega_c t$

derive expression for amplitude modulated (AM) wave AM(t)

Ans:- $A_c \sin \omega_c t + \frac{A_c m_a}{2} \sin 2\pi (F_c + F_m) t + \frac{A_c m_a}{2} \sin 2\pi (F_c - F_m) t$

~~$\sin 2\pi (f_c - f_m) t$~~

where;

Q2| Assume $m(t) = A_m \sin \omega_m t$

$c(t) = A_c \cos \omega_c t$

$\Rightarrow$ So, $a_m = A_m \sin \omega_m t$ — (1)

$a_c = A_c \cos \omega_m t$ — (2)

The amplitud modulated wave (A) is given as:-

$A = A_c + a_m$ ------ (3)

putting am value in equatio (3) from equation (1),

$A = A_c + A_m \sin \omega_m t$

~~AM(t)~~

∴ Amplitude Modulation,

$AM(t) = (A_c + A_m \sin \omega_m t)$ ~~sin ωct~~ $\cos \omega_c t$

~~= Ac sin ωct~~

$= A_c \cos \omega_m t + A_m \sin \omega_m t \cdot \cos \omega_m t$

$= A_c \cos \omega_m t + m A_c \sin \omega_m t \cdot \cos \omega_m t$

$$= A_c \cos \omega_m t + \tfrac{1}{2} \cdot 2\, m A_c \sin \omega_m t \cdot \cos \omega_m t$$

$$= A_c \cos \omega_m t + \frac{m A_c}{2} \left(\sin 2 \omega_m t \right)$$

$$= A_c \cos \omega_m t + \frac{m A_c}{2} \cdot \sin 2 \omega_m t$$

$$= A_c \cos 2\pi f_m t + \frac{m A_c}{2} \cdot \sin 2\pi f_m t$$

- Square law Modulator
- Switching Modulator

} Two modulators generate AM wave

Square law Modulator

The circuit that generates the AM waves is called as amplitude modulator. Generation of AM waves using the square law modulator could be understood in a better way by observing the square law modulator circuit shown in the above figure.

→ It consists with:-

→ A Non-linear device

→ A bandpass Filter

→ A carrier source & modulating signal

A square law modulator requires three features.

① A means of summing the carrier & modulating waves, a

② A non linear element,

③ A band pass Filter For extracting the desired modulation products.

Semi Conductor diodes & transistors are the most common non-Linear devices used for implementing square law modulators.

$c(t)$ = Carrier signals

$m(t) \rightarrow$ message signals

$f_c \rightarrow$ Frequency

$c(t) \cdot m(t) \rightarrow$ Expected output of a product modulator.

$$v_2(t) = a_1 v_1(t) + a_2 v_1^2(t)$$

$a_1, a_2 \rightarrow$ constants

$v_2(t)$ = output from non linear device

$v_1(t) \rightarrow$ The input to the non linear device

The Modulating signal & carrier are connected in series with each other & their sum $V_1(t)$ is applied at the input of the non-linear device, such as diode, transistor etc.

Thus

$v_1(t) = x(t) + E_c \cos(2\pi f_c t)$ — (1)

$v_2(t) = a v_1(t) + b v_1^2(t)$ — (2)

[The input output relation for non-linear device is as under].

Now, substituting (1) in (2),

$v_2(t) = a[x(t) + E_c \cos(2\pi f_c t)] + b x^2(t) + 2b x(t) \cos(2\pi f_c t) + b E_c^2 \cos^2(2\pi f_c t)$

$a x(t)$ → Modulating signal

$a E_c \cos(2\pi f_c t)$ → Carrier signal

$b x^2(t)$ → squared modulating "

$2b x(t) \cos(2\pi f_c t)$ → AM wave with only sidebands

$b E_c^2 \cos^2(2\pi f_c t)$ → squared carrier

$v_o(t) = aE_c \cos(2\pi F_c t) + 2bn(t) E_c \cos(2\pi F_c t)$

or,

$v_o(t) = [aE_c + 2bn(t) E_c] \cos(2\pi F_c t)$

Therefore,

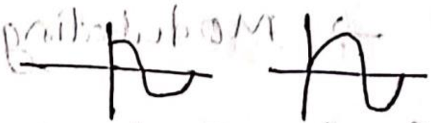
$v_o(t) = aE_c\left[1 + \frac{2b}{a} x(t)\right] \cos(2\pi F_c t)$ —③

Comparing this with the expressing for standard AM wave,

$s(t) = E_c [1 + m x(t)] \cos.(2\pi F_c t)$.

$v_o(t) = a_1 v_i(t) + a_2 v_i^2(t) + a_3 v_i^3(t)$ —①

$v_i(t) = m(t) + c(t)$



$= A_c \cos 2\pi F_c t + m(t)$ —②

So, $v_o(t) = a_1 A_c \cos 2\pi F t + 2a_2 A_c m(t) \cos 2\pi F_c t$

The Fourier transformation of $v_0(t)$ is,

$$v_0(f) = \frac{a_1 A_c}{2}\left[\delta(f - f_c) + \delta(f + f_c)\right] + \frac{2 a_2 A_c}{2}\left[M(f - f_c) + M(f + f_c)\right]$$

$$v_0(f) = \frac{a_1 A_c}{2}\left[\delta(f - f_c) + \delta(f + f_c)\right] + a_2 A_c \left[M(f - f_c) + M(f + f_c)\right]$$

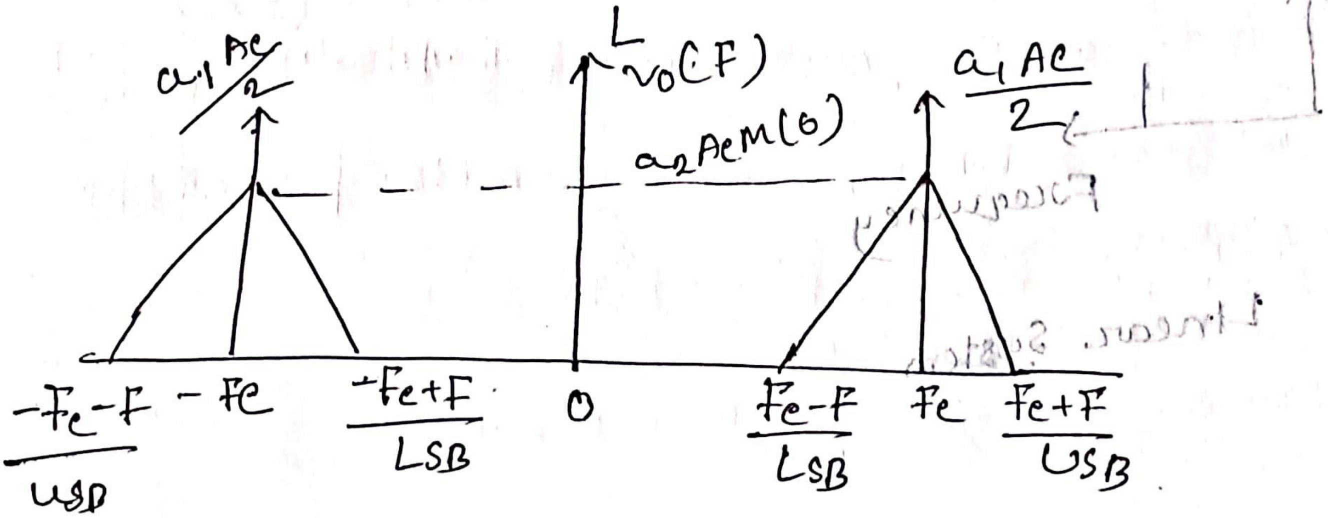


Fig: Spectrum of AM signal

Working operation and Analysis

Forward bias → positive

Reverse bia → Negative

Forward bias is output voltage $V2(t) = V1(t)$

In the positive half cycle of $C(t)$ &

~~$V2(t)=0$~~

$C(t)$ Negative half cycle $V2(t) = 0$,

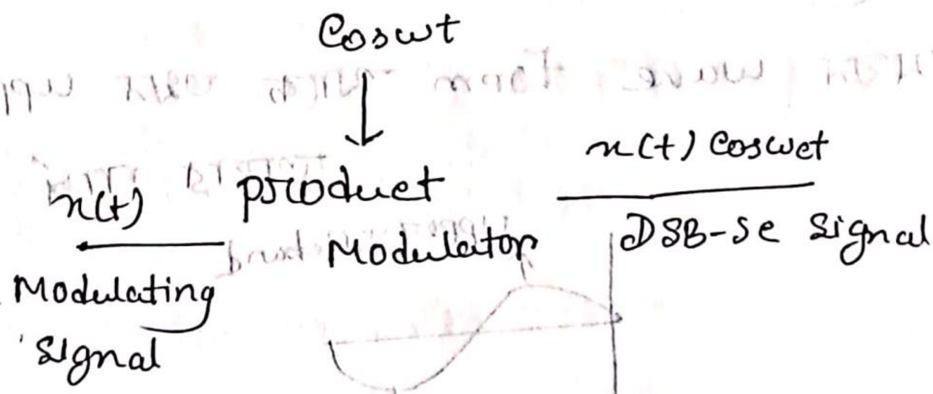
Hence, $V2(t) = VI(t)$ For $C(t) > 0$

$V2(t) = 0$ For $C(t) < 0$

In other words the load voltage $V2(t)$ varies periodically between the values $VI(t)$ at the rate equal to carrier frequency Fc

$V_2(t) = V_1(t) \cdot$ ____

Generation of DSB-SC Signal



DSB-SC wave

$$s(t) = m(t)\, c(t)$$

$m(t) \rightarrow$ Modulating Carrier

$c(t) \rightarrow$ Carrier

$$\Rightarrow A_m A_c \cos(2\pi f_m t) \cos(2\pi f_c t)$$

Bandwidth of DSB SC wave :-

$$BW = f_{max} - f_{min}$$

DSBSC modulating wave,

$$s(t) = A_m A_c \cos(2\pi f_m t) \cdot \cos(2\pi f_c t)$$

$$\Rightarrow s(t) = \frac{A_m A_c}{2} \cos[2\pi(f_c + f_m)t] + \frac{A_m A_c}{2} \cos[2\pi(f_c - f_m)t]$$

- - -

. - -

Power Calculations of DSBSC wave :-

$$P_t = P_{USB} + P_{LSB}$$

$$P = \frac{V_{rms}^2}{R} = \frac{(V_m/\sqrt{2})^2}{R}$$

$$P_{USB} = \frac{(A_m A_c / 2\sqrt{2})^2}{}$$

$$\therefore P_{USB} = \frac{A_m^2 A_c^2}{8R}$$

Total power of DSBSC wave,

$$P_t = \frac{A_m^2 A_c^2}{8R} + \frac{A_m^2 A_c^2}{8R}$$

[P_t = Total power]

$$\Rightarrow P_t = \frac{A_m^2 A_c^2}{4R}$$

Single Tone Modulation

$S(t) = A.$

*

(*) Fourier transformation করার হয় যেনো আমরা equation হতে spectrum draw করতে পারি।

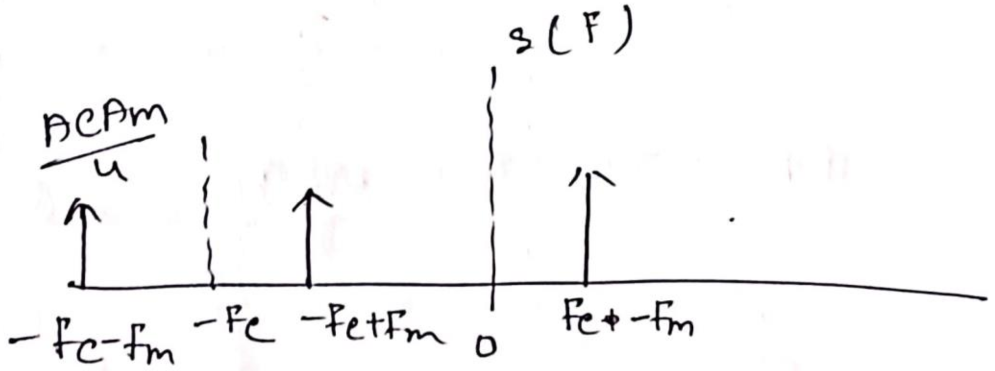
~~$m(t) = A_m \cos$~~

$$S(t) = A_c A_m \cos(2\pi F_c t) \cdot \cos(2\pi f_m t)$$

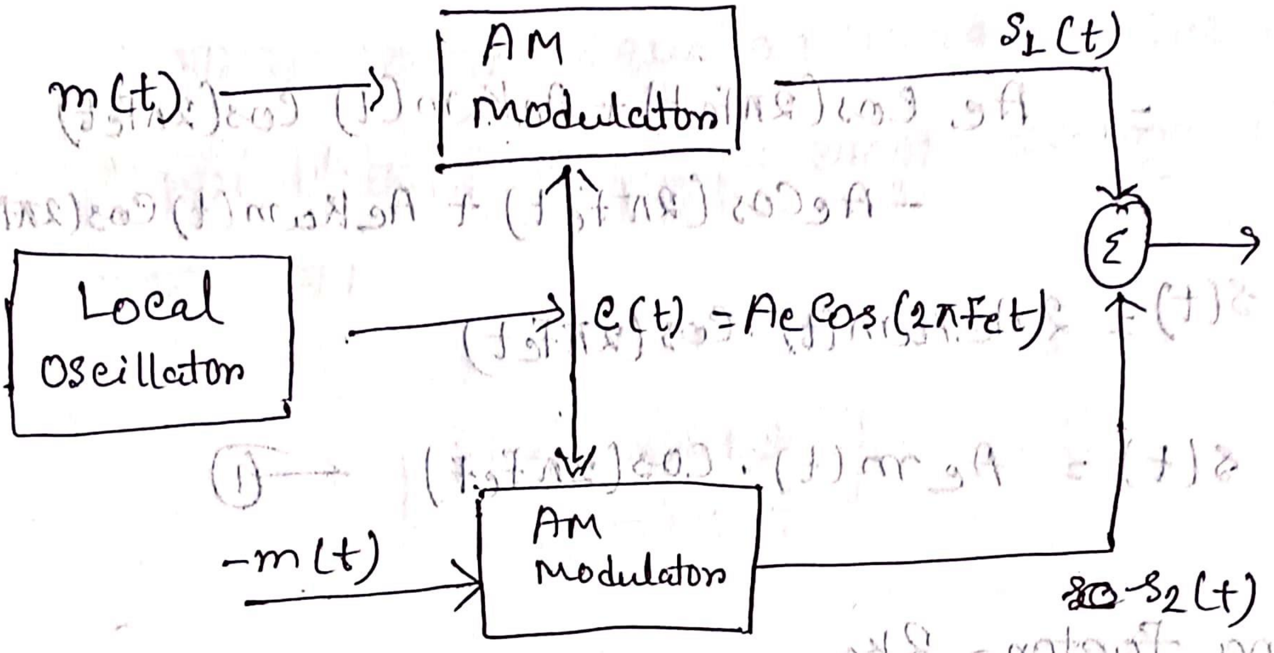
$\Rightarrow$

$$S(F) \Rightarrow \frac{A_c A_m}{4}\left[\delta(F - F_c - F_m) + \delta(F + F_c + F_m)\right]$$

$$+ \frac{A_c A_m}{4}\left[\delta(F - F_c + F_m) + \delta(F + F_c - F_m)\right]$$



Balanced Modulator



=) DSBSC তে USB ও LSB থাকে। এখন কোনো SB যেনো বড় ছোট না হয় ~~আসলে~~ যে কারনেই ~~BL~~ Balanced Modulator করা হয়।

Modulating signal 2 types: positive, Negative
m(t), -m(t)

Output of the upper AM modulator is,

$$s_1(t) = A_c[1 + k_a m(t)] \cos(2\pi f_c t)$$

Output of the lower AM Modulator is,

$$s_2(t) = A_c[1 - k_a m(t)] \cos(2\pi f_c t)$$

So, $s(t) = s_1(t) - s_2(t)$

$$= A_c \cos(2\pi f_c t) + A_c k_a m(t) \cos(2\pi f_c t) - A_c \cos(2\pi f_c t) + A_c k_a m(t) \cos(2\pi f_c t)$$

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

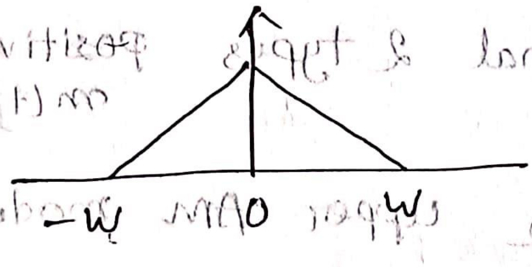
$$s(t) = A_c m(t) \cdot \cos(2\pi f_c t) \quad \text{--- (1)}$$

⇒ Scaling Factor = $2k_a$

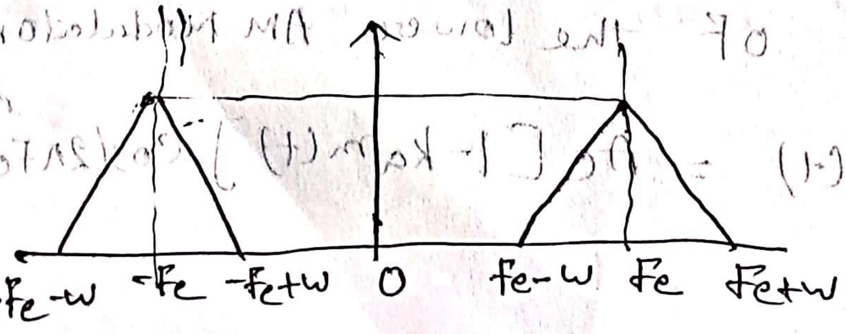
(1) কে Fourier transformation করলে,

~~$\delta(F - f_c) + \delta(F + F_c)$~~

$$S(F) = k_a A_c [M(F - f_c) + M(F + f_c)]$$



⇒ Spectrum of baseband signal



* **Scaling Factor:**- যদি কোনো কারনে আমরা কোনো equation এ কোনো specific বিষয় না জানি তখন ঐ তাকে scaling factor বলা হয়।

Ring Modulator

positive দিলে D_1, D_3 ON → D_2, D_4 (OFF)

Negative " D_2, D_4 ON হবে। → D_1, D_3 (OFF)

$$c(t) = \frac{4}{\pi} \sum_{n=1}^{\infty} \frac{(-1)^{n-1}}{2n-1} \cos\left[2\pi f_c t(2n-1)\right]$$

⇒ কোনো fourier Transformation Odd even পাইলে – Odd even হয়।

s(t) Combination এর পর,

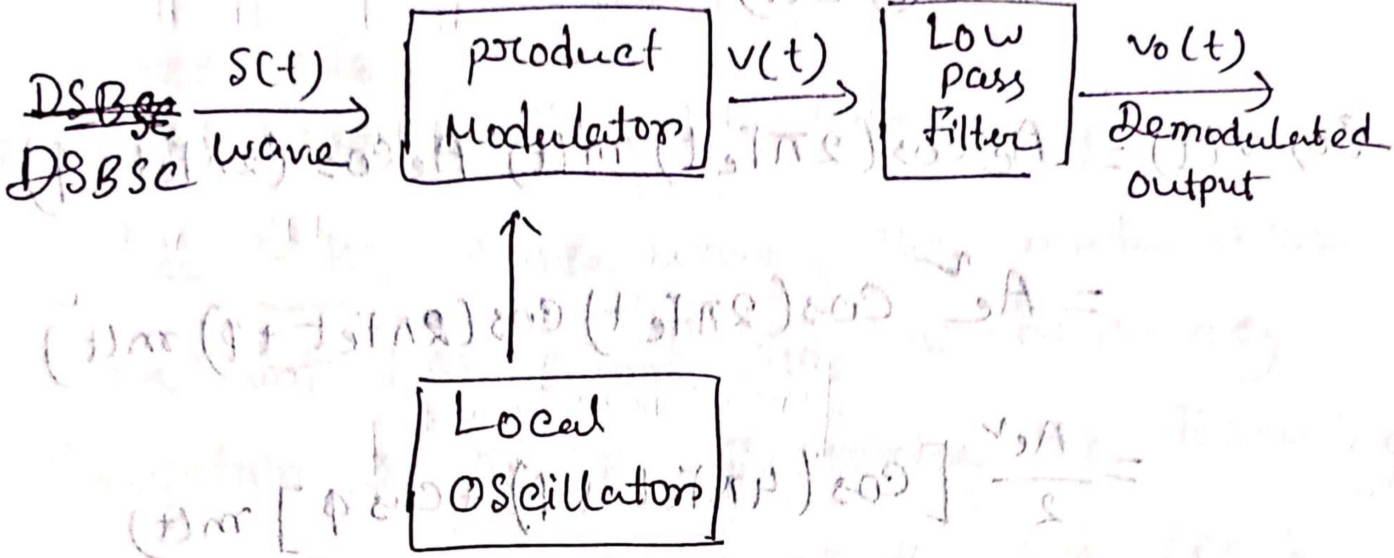
$$s(t) = \frac{4}{\pi} \sum \frac{(-1)^{n-1}}{2n-1} \cos[2\pi F_c t (2n-1)] m(t)$$

$$s(t) = \frac{4}{\pi} \cos[2\pi F_c t (2n-1)] m(t)$$

Fourier series,

s(t) =

Conherent Detector



→ message signal

Let the DSBSC wave be,

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

The output of the local oscillator is,

$$c(t) = A_c \cos(2\pi F_c t + \phi)$$ → (phase difference)

এখানে φ টা আবার DSBSC demodulator USB, LSB কে এখানে pos এ +90° or +180° Neg এ -90° or -180° হবে।

Output of product modulator,

$$v(t) = s(t)\, c(t)$$

So, $v(t) = A_c \cos(2\pi f_c t)\, m(t)\, A_c \cos(2\pi f_c t + \phi)$

$$= A_c^2 \cos(2\pi f_c t) \cos(2\pi f_c t + \phi)\, m(t)$$

$$= \frac{A_c^2}{2} [\cos(4\pi f_c t + \phi) + \cos\phi]\, m(t)$$

$$v(t) = \frac{A_c^2}{2} \cos\phi\, m(t) + \frac{A_c^2}{2} \cos(4\pi f_c t + \phi)\, m(t)$$

Low pass filter,

$$v_o t = \frac{A_c^2}{2} \cos\phi\, m(t)$$

Demodulated signal will be maximum, when $\phi = 0°$

will be zero when $\phi = \pm 90°$

There will be an effect if $\phi = \pm 90°$

(28)

Single Sideband Surpressed Carrier (SSBSC)

107.6 MHz

□ ~~6 MHz~~ Carrier signal is frequency modulated by a 7 KHz sine wave. The ~~modulation~~ resultant FM signal has a frequency deviation of 50 KHz. Determine the following:-

(1) The carrier swing of the FM signal

(2) The highest & the lowest frequencies attained by the modulated signal

(3) The modulation index of the FM wave.

⇒ Here,

$f_c = 107.6$ MHz

$f_m = 7$ KHz

$\Delta f = 50$ KHz

∴ Carrier swing = 2 × Frequency deviation

= 2 × 50

= 100 KHz

(Ans)

② Highest Frequency.

$F_H = F_c + \Delta F$

~~= (107.6 + 50)~~

$= 107.6 \times 10^6 + 50 \times 10^3$

$=$ ~~107630 Hz~~ 107550×10^3

$= 107.55$ MHz

Lowest Frequency,

$F_L = F_c - \Delta F$

$= 107.6 \times 10^6 - 50 \times 10^3$

$= 107550000$

$= 107.55$ MHz

(Ans)

(3)

Modulation Index, $m_f = \frac{\Delta F}{F_m}$

$= \frac{50 \times 10^3}{7 \times 10^3}$

$= \frac{50}{7}$

$= 7.143$ (Ans)

Determine the Frequency Deviation & Carrier swing for FM.

=>

Here resting or Carrier Frequency, F_c = 105.00 MHz

Upper Frequency, F_H = 105.007 MHz

lowest Frequency, F_L = ?

=> Here,

$\Delta F = F_H - F_c$

$= (105.007 - 105) \times 10^6$ Hz

$= 7000 Hz = 7$ KHz (Ans)

So, Carrier swing $= 2 \times 7 = 14$ KHz (Ans)

Lowest Frequency, $F_L = F_c - \Delta F$

$= ~~(105.000 - 7)~~$ ~~KHz~~

~~= 104993 KHz~~

= 10~~4.993~~ ~~Hz~~ ~~MHz~~

Ans

10^3
10^2
10
1
10
10^{-2}
10^{-3}

$= \left(\left(\frac{105}{10^3}\right.\right.$

$=$ ~~(105000 − 7) KHz~~

~~= 104993 KHz~~

$= (105 - 0.007)$ MHz

$= 104.993$ MHz

(3) $\Delta F = 20 KHz$

(1) Determine the percent Modulation of this signal if it is broadcasted in the 88 -108 MHz band

(2) Caculate the percent modulation if this signal is broadcasted as the audio portion of a television broadcast

(1)

=> Here

Actual Deviation, $\Delta F = 20 KHz$

we know,

$$M = \frac{\Delta F_{actual}}{\Delta F_{max}} \times 100\%$$

The maximum ~~frequency of~~ FM broadcast band is 75 KHz

$$M = \frac{20 \times 10^3}{75 \times 10^3} \times 100\%$$

$= 26.67\%$

Ans

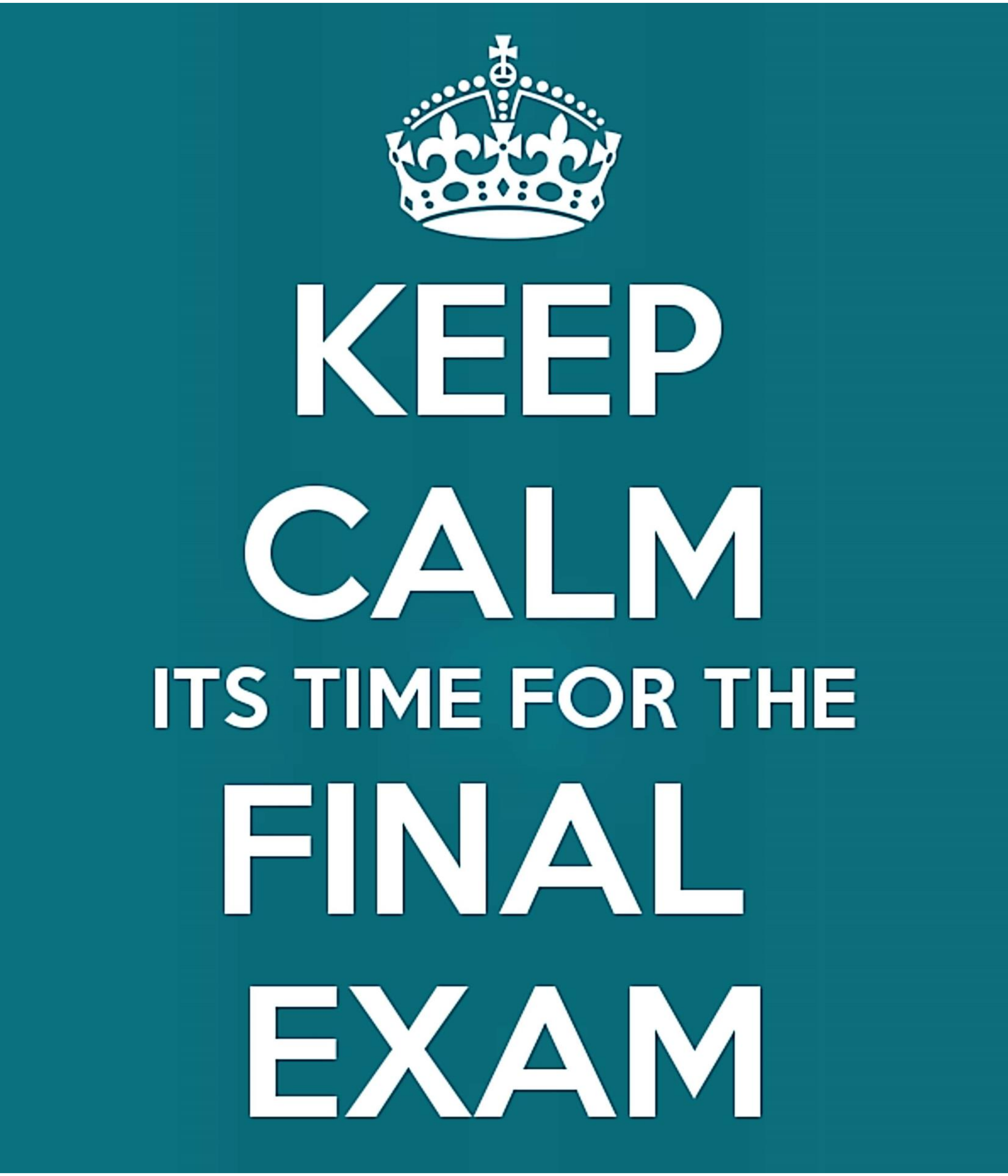
(2) The audio portion of a television broadcast

$= 25 KHz$

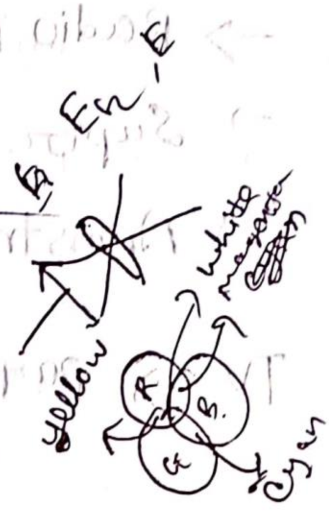
$$\therefore M = \frac{20\times10^3}{25\times10^3}\times100\%$$

$= 80\%$

(Ans)


KEEP
CALM
ITS TIME FOR THE
FINAL
EXAM

Need For Frequency Mixing:-



Final Exam

Basic Communication

TV :- RF Tuner → Receive করবে

=> Justify the choice ... (vvIm)

=> Color Mixing (vvIm) → (31)

=> Math related to TV (Last slide)

=> 8, 9 slide

=> 3,4 slide

(vvIm)

TV 2to5টা Question

Suggestion:-

Part-B

Noise
- → বিভিন্ন প্রকার Noise
- → Effect of Noise → (all) equation
- → SSB
- → DSBSC
- → AM Receive
- → Ex-5.1.1
- → FM → part-A & B both

Spring - 2019

(1) (a) precautions to design a master oscillator:—

(i) Oscillator should be enclosed in constant temperature

(ii) Stablized power supply should be used so that electrode voltages do not vary

(iii) Effective Q on the tank circuit should be kept as high as possible

(iv) Oscillator circuit should be so arranged that there is small coupling from the tank circuit to the base & collector (grid & anode) of the oscillator transistor (tube).

(v) Master oscillator should operate at sub harmonic of the carrier frequency

(vi) In the case of electron tube oscillator, grid leak biasing should be used.

(b) Causes of Frequency drift:-

An undesired ~~change~~ progressive change in Frequency with time. Frequency drift can be caused by instability in the oscillator & environmental changes.
Although it is often hard to distinguish between drift & oscillator aging. Frequency drift may be in either direction (resulting in a higher or lower Frequency) & is not necessarily linear.

(C)

Fourth order harmonic the impedance of the ~~tube~~ tuned circuit is,

$$Z_i = \frac{2}{75} R_t$$

P.T.O

Let, $\omega = \frac{\omega_0}{n}$ [n = being the order of harmonic]

Capacitor C in parallel with an inductor of inductance L & resistance R

$$Q_0 = \frac{\omega_0 L}{R} = \frac{1}{\omega_0 C R}$$

The tank impedance at frequency ω is given by,

$$Z_t = \frac{\frac{1}{j\omega C}[R + j\omega L]}{\frac{1}{j\omega C} + [R + j\omega L]}$$

$$= \frac{R + j\omega L}{1 + j\omega C(R + j\omega L)}$$

Dividing both numerator & denominator by $j\omega CR$,

$$Z_t = \frac{\frac{L}{CR} - \frac{j}{\omega C}}{1 + j\left[\frac{\omega L}{R} - \frac{1}{\omega CR}\right]} = \frac{\frac{L}{CR} - \frac{j}{\omega C}}{1 + jQ_0\left(\frac{\omega}{\omega_0} - \frac{\omega_0}{\omega}\right)}$$

1 can be neglected in comparison with $jQ_0\left[\frac{\omega}{\omega_0} - \frac{\omega_0}{\omega}\right]$

Also $\frac{1}{j\omega C}$ may be neglected in comparison with ~~1/ω~~ L/CR.

$$Z_t = \left(\frac{L}{CR} - \frac{j}{Q_0}\right) / \left(\frac{\omega_0}{\omega} - \frac{\omega}{\omega_0}\right)$$

Subharmonic of the output freq = $\omega = \frac{\omega_0}{n}$

Here,

$n = 2,\ Z_t \approx \frac{L}{CR} \cdot \frac{j}{Q_0} \cdot \frac{2}{3}$ $\left(\frac{\omega_0}{\omega} - \frac{\omega}{\omega_0}\right)$

$n = 3,\ Z_t \approx \frac{L}{CR} \cdot \frac{j}{Q_0} \cdot \frac{3}{8}$ $\omega = \frac{\omega_0}{n}$

$n = 4,\ Z_t \approx \frac{L}{CR} \cdot \frac{j}{Q_0} \cdot \frac{4}{15}$ etc $\frac{2\omega_0}{\omega_0} - \frac{\omega_0}{2\omega_0}$

$\frac{4\omega_0 - \omega_0}{2\omega_0}$

$\frac{L}{CR}$ is the impedance of the tank circuit at the frequency of resonance $\frac{3\omega_0}{2\omega_0}$

$n = 2 \quad Z_t = \frac{1}{15} R_t$

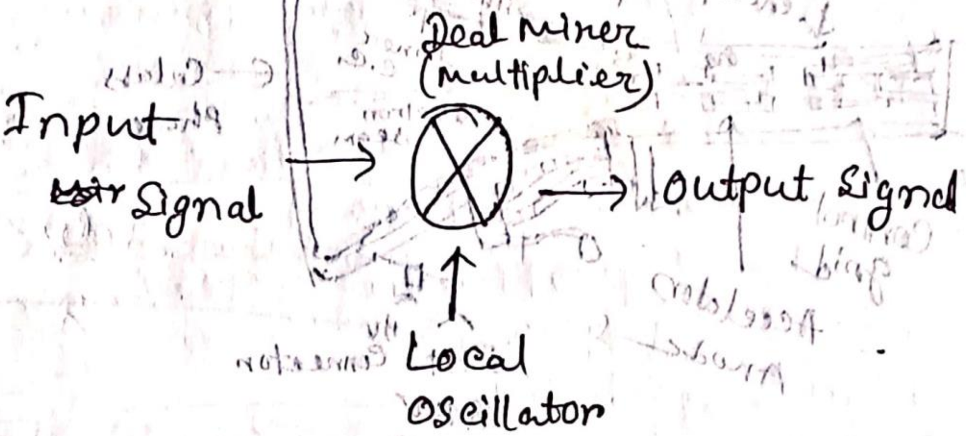
$n = 3 \quad Z_t = \frac{3}{80} R_t$

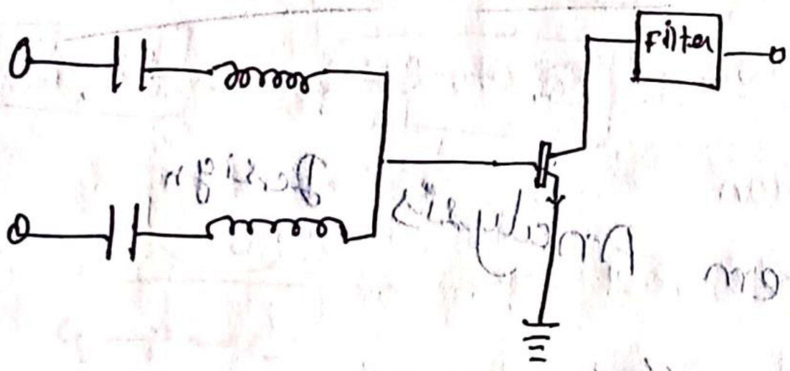
$n = 4 \quad Z_t = \frac{2}{75} R_t$

(2) (b)

(a) Frequency mixer circuit using two transistors:

=)

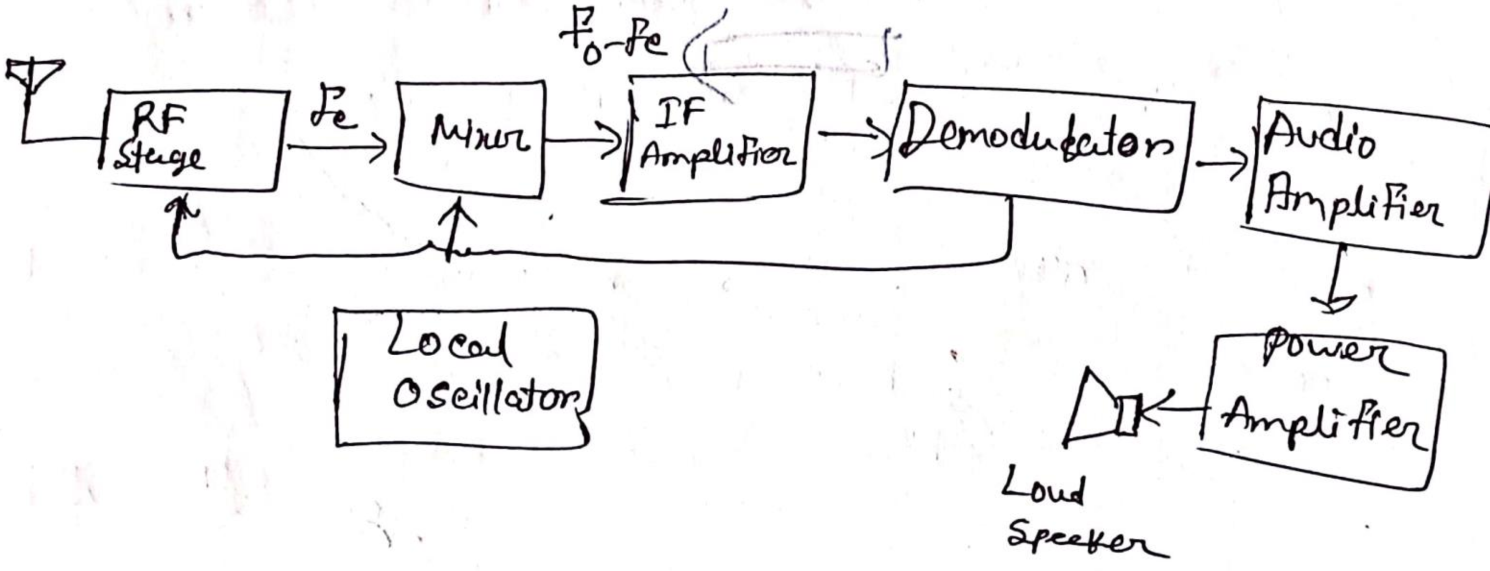




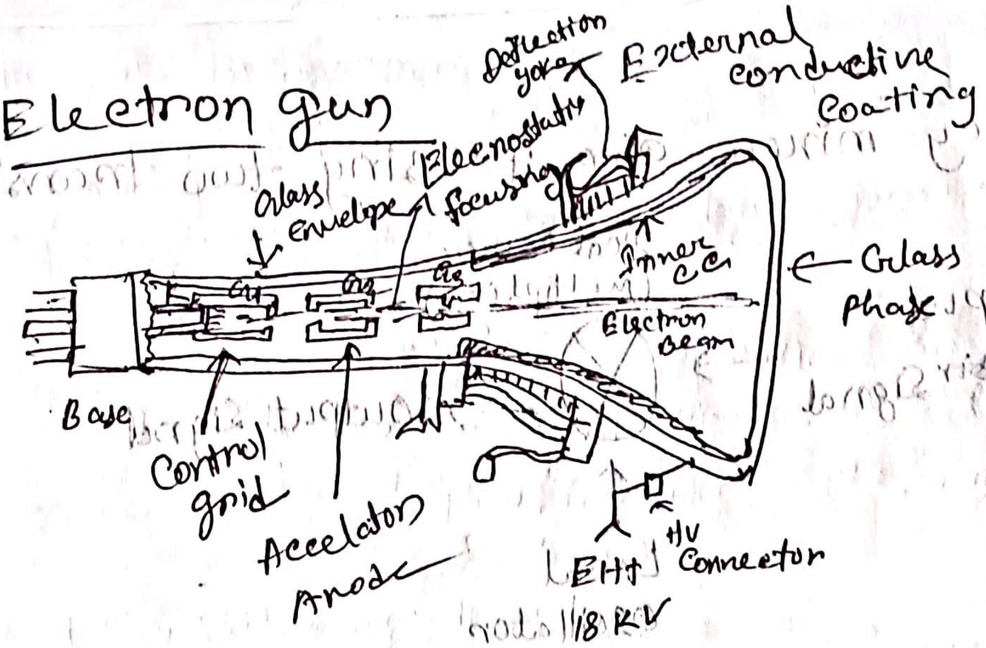
Bipolar Mixer circuit

(b)

3(a) 2- Superheterodyne



Electron gun



System Analysis & Design Development

Basic Communication System :-

- Communication is the basic step for exchange of information.
- Communication is the bridge to share.
- Communication can be defined as the process of exchange of information through means such as words, actions, signs, etc between two or more individuals.

Definition of Communication :-

→ Communication is the process of establishing connection or link between two points for information exchange.

- It is simply the basic process of exchanging information.
- It is exchanged between individuals through a medium.

– Communication can also be defined as the transfer of information from one point in space and time to other point.

Main objective of Communication:-

Sender to receiver এর মধ্যে কোনো Message অথবা Information কে Collect করা বা পাঠানোর জন্য - কোনো error, noise or distortion ছাড়া less possible time এ পাঠাইতে পারাই Main Objective of Communication.

→ Collect information from the sender completely.

→ Transmit this information as much possible in less time.

→ Deliver this info to the receiver without any error.

→ Transmit more information as much as possible.

* Equipments which are used for communication purpose are called Communication equipments.

parts of Communication System :-

Sender → Channel → Receiver

Sender	Channel	Receiver
who sends message (Can be a transmitting station from where the signal is transmitted)	(Medium) (Through which signals travel to reach the destination)	(who receives the message.) (Can be receiving station where the transmitted signal is being received)

Block Diagram of Common System :-

* Information or input Signal.
(Any Information)

* Input Transducer (Natural Signal হতে Electrical Signal -এ Convert করে)

* Transmitter (Message ও Carrier Signal কে একত্রিত করে Transmit এর জন্য উপযোগী করে তোলে)

* Communication Channel or medium

* Receiver

* Noise (এটা Message Signal এ থাকা বেকার Signal)

* Output Transducer (Information কে output Transducer এর মাধ্যমে কে output দেওয়া হয়)

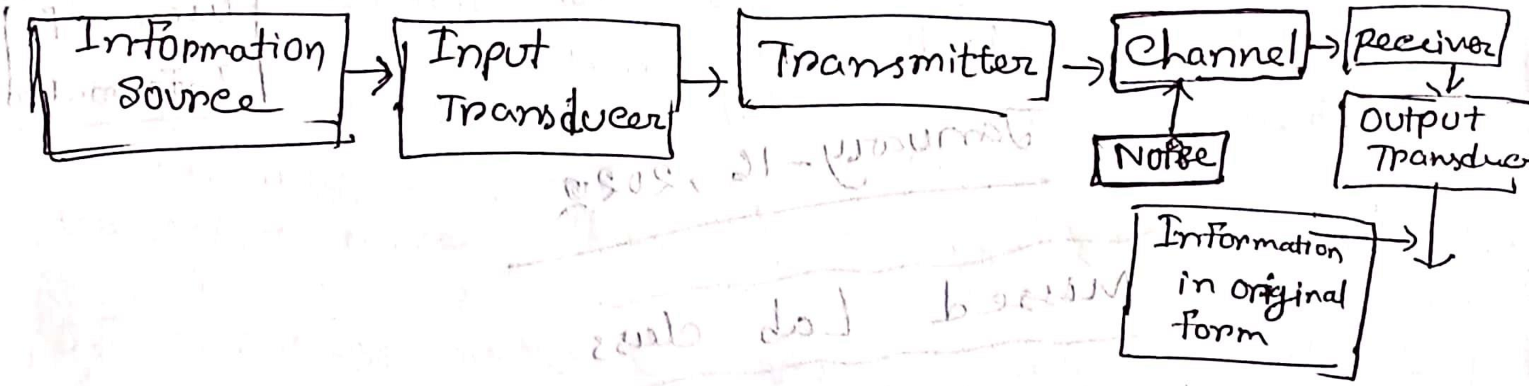


Fig: Block Diagram of Communication System.

BTS → Base Transmit Station

or, Base Transeiver Station

* কোনো মাধ্যমে Unlimited Distance Cover করতে।

CCE - 2407

(Basic communication Engineering)

Modulator

It happens (Modulation) in transmitter

=> To transmit over a large distance of message signal because of their low frequency and amplitude wave called carrier wave. This phenomenon of superimposing of message with a carrier wave is called modulation.

The resultant wave is a modulated wave which is to be transmitted.

Amplitude Modulation (AM):-

The process of changing the amplitude of signal by wave by impressing or superimposing it on a high-frequency carrier wave, keeping its frequency constant is called amplitude modulation.

Frequency Modulation (FM):-

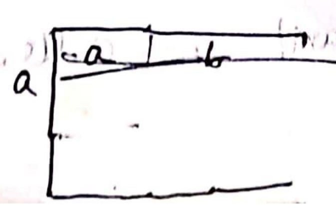
It's a technique in which the frequency of the message signal is varied by modulating with a carrier wave.

Phase Modulation (PM):-

It changes the phase of the signal wave. The phase shift after modulation is dependent on the frequency of the carrier wave as well. Phase modulated waves are immune to noise to a greater extent.

Demodulator:- Inverse phenomenon of modulation. The process of seperation of message signal from the carrier wave takes place in the demodulator. The info

a+b $(a^2+b)^2 = a^2+b^2+2ab$



Amplifier:- Signal [illegible] Amplitude [illegible] [illegible] Strength of the transmitted signal is called an amplifier. It can be done anywhere in between transmitter & receiver. A DC power source will provide for the amplification.

Antenna:-

It is a structure or a device that will ~~redice~~ rediate and receive ~~&~~ electromagnetic waves. So, they are used in both transmitters & receivers.

It is a metallic object. Often a collection of wires. The electromagnetic waves are polarised according to the position of antenna.

Attenuation:-

It is a problem caused by the medium. When the signal is propagating for a long distance through a medium, depending on the length of the medium the initial power decreases.

The loss in initial power ∝ length of the medium.

Digital signals are comparatively less prone to attenuation than analogue signals.

Distortion:- Signal বাধাপ্রাপ্ত হওয়া।

- It is also another types of channel problem.

→ যখন মেইন সিগনালটা বাধাপ্রাপ্ত হয়ে পরিবর্তিত হয়।

→ The distorted signal may have frequency & bandwidth different from the transmitted signal

→ It can be linear or non-linear

Repeaters:-

It is placed at different locations in between the transmitter & receiver.

A repeater receives the transmitted signal, mplifies it & send it to the next repeater without distorting the original signal.

Types of Communication System:-

① Based on the way of Communication:

(i) One way or Simplex

(ii) Two way or Duplex

② Based on the Form of signals:-

(i) Analog Communication System

(ii) Digital Communication System

③ Based on the Communication Channel:-

(i) Line Communication (wire, coaxial Cable, optical cable, twisted wire etc)

(ii) Space Communication (Ground waves, Sky waves, Space waves, Satellite Communication)

Types of Signals :-

* Conveying ~~some~~ an information by some means such as gestures, sounds, actions etc. can be termed as signalling.
A signal can be a source of energy which transmits some info.
This signal helps to establish a communication between the sender and the receiver.

* An electrical impulse or an electromagnetic wave which travels a distance to convey a message, can be termed as a signal in communication systems.

* Depending on their characteristics, signals are mainly classified into two types: Analog & digital. Analog & digital signals are further classified.

Signals
- Analog
  - Periodic
  - Aperiodic
- Digital
  - periodic
  - Aperiodic

Analog Signal :-

প্রতিটি সময়ের জন্য signal vary করবে বা signal পরিবর্তিত হবে। অর্থাৎ প্রতিটি সময়ের জন্য তার value থাকবে।

* Time varying quantity can be understood as Analog Quantity.
* The communication Based on analog signals & analog values is called as Analog Communication.

Digital Signal :-

- Discrete in nature,
- Non-continuous in Form are called as Ds. 0, 1 দ্বারা প্রকাশ করা হয় Binary তে।

Signals
- Analog
  - Periodic
  - Aperiodic
- Digital
  - periodic
  - Aperiodic

Analog signal :-

প্রতিটা সময়ের জন্য signal vary করবে যা signal পরিবর্তিত হবে। অর্থাৎ প্রতিটা সময়ের জন্য তার value থাকবে।

- Time varying quantity can be understood as Analog quantity.
- The communication Based on analog signals & analog values is called as Analog communication.

Digital signal :- - Discrete in nature,

- Non-continuous in Form are called as Ds. 0, 1 দ্বারা প্রকাশ করা হয় Binary তে।

Periodic Signal:-

সময়ের সাথে pattern কে match করে থাকে।

→ Any analog or digital signal that repeats its pattern over a period of time, is called as a periodic signal.

→ This signal has its pattern continued repeatedly and is easy to be assumed or to be calculated.

Aperiodic Signal:

এক্ষেত্রে এর amplitude এর ক্ষেত্রে সবসময় একই থাকবে না বরং vary করবে।

Need For Modulation:-

⇒ Baseband signals are incompatible for direct transmission.

For such a signal, to travel longer distances, its ~~ste~~ strength has to be increased by modulating with a high-frequency carrier wave, which doesn't affect the parameters of the modulating signal.

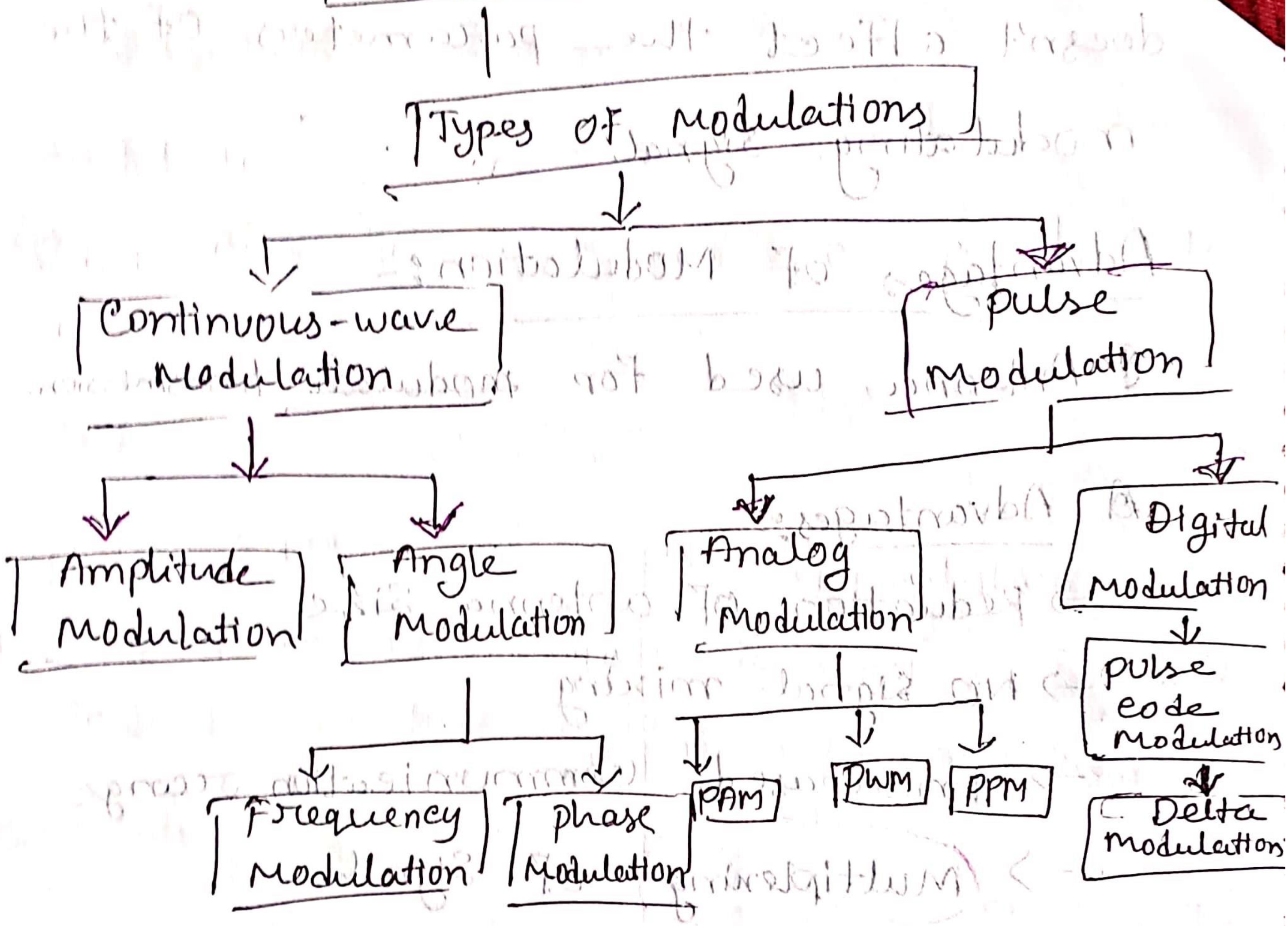
Advantages of Modulation:-

① Antenna used for ~~modulati~~ transmission.

A Advantages:-

-> Reduction of antenna size
-> No signal mixing
-> Increased communication range
-> Multiplexing of signals.
-> possibility of bandwidth adjustments
-> Improved reception quality

Types OF Modulation



[1] Continuous wave Modulation :- (Sine wave used as a Carrier wave)

Amplitude Modulation :-

IF the amplitude OF the high Frequency Carrier wave is varied in accordance with the Instantaneous amplitude OF the modulating signal, then such a technique is called as Amplitude Modulation.

Angle: IF the angle of the Carrier wave is varied in accordance with the instantaneous value of modulating signal, then such a technique is called as Angle Modulation.

- IF the Frequency of the Carrier wave is varied, in accordance with the instantaneous value of the moduling signal, the such a technique is called as <u>Frequency Modulation</u>

- IF the Phase of the high Frequency Carrier wave is varied in accordance with the instantaneous value of the moduling signal, then such a technique is called as <u>phase Modulation</u>.

- <u>pulse Modulation:-</u>

One kind of digital signal. Sequence of rectengular pulses, A Carrier wave. This is further divided into analog and digital Modulation.

Demodulation :-

যেখানে message ও carrier কে seperate করা হয়।

Difference between

Modulation	Demodulation
① process of influencing data information on the carrier.	① Recovery of original information at the distant end of the carrier
② Modem ~~dose~~ can do this	② Modem can do this too
③ Aim to acheieve transfer information with the minimum distortion minimum loss, and efficient utilization of spectrum.	③ (Same)

Radio Frequency Bands :-

It is one of such parts of the electromagnetic spectrum that overlaps our sub-THz range at its lower end.

Electromagnetic waves in this frequency range are called radio frequency bands or simply radio-waves.

RF Bands- 30KHz - 300 GHz

All known transmission systems are operated in the RF spectrum range including analog radio, aircraft navigation, marine radio....

RF Frequency Bands :-

International Telecommunication Union (ITU) (Geneva, Switzerland)

→ এরা কোনো technology এর operating frequency কে fix করে থাকে।

Band ---

এক্ষেত্রে কোনো Distortion হয় না।

The modulation index is the ratio of the maximum amplitude of the message signal to the maximum amplitude of carrier signal.

For Example:-

If the message signal maximum Amplitude is 4 volts & Carrier signal maximum amplitude is as 4 volts then the ratio = 1.

So, the modulation index in perfect modulation is equal to on ($M_i = 1$)

⊛ Modulation Index also known as the Modulation Depth.

The perfect Modulation has a modulation depth at 100%.

In perfect-Modulation the carrier level Falls to zero.

Under Modulation:-

যদি Modulation Index এর Value 100% এর ছোট অর্থাৎ 1 হতে ছোট হলে Under Modulation বলে।

এর ফলে Signal এ কোনো Distortion হয় না।

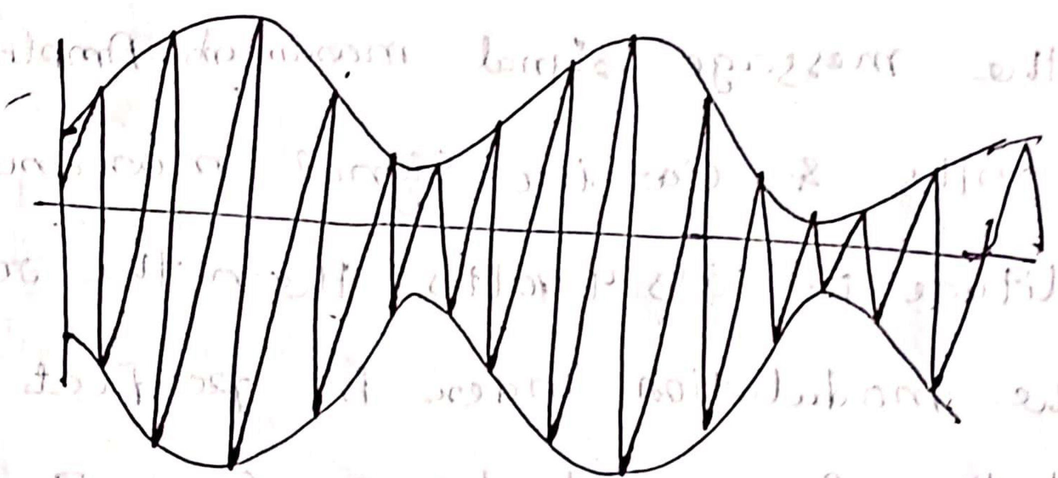


Figure: Under Modulation.

Over-Modulation:-

Greater than 100% or 1,

Greater than the maximum Amplitude of the carrier signal ($A_m > A_c$)

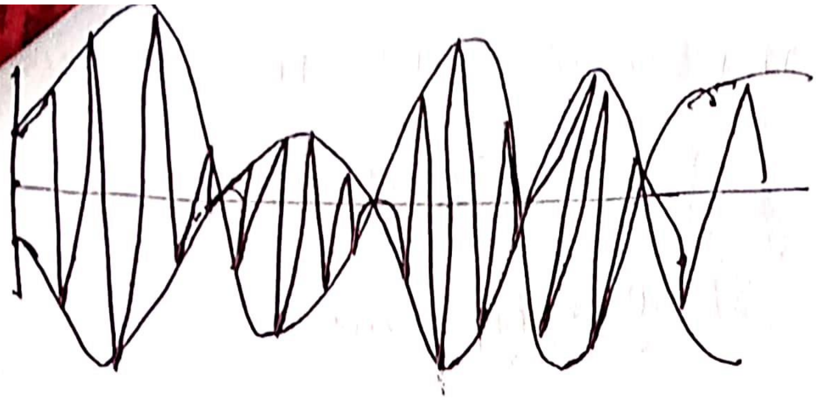


Figure:- Over modulation.

modulation index will be less than one or equal to one ($M <= 1$) when $A_m <= A_c$.

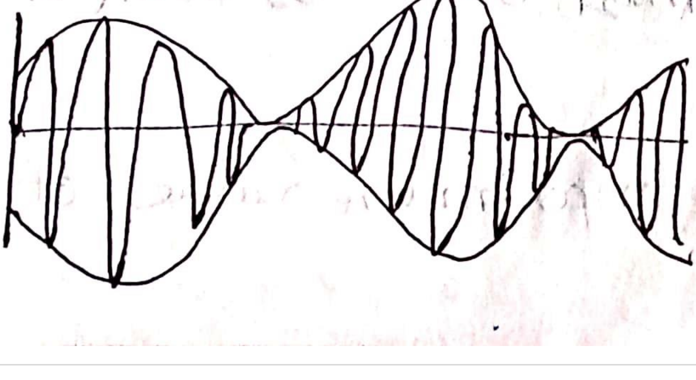
The minimum value of the modulation index will be zero.

There are three types of Modulation :-

1) perfect - Modulation.
2) Under - Modulation.
3) Over - Modulation.

(a) perfect Modulation :-

যখন Maximum ~~Frequency~~ Amplitude of the message signal or Modulated signal exactly equal to the carrier signal হলে তখন perfect Modulation হয়। ($A_m = A_c$)



$$M_i = \frac{A_{max} - A_{min}}{A_{max} + A_{min}}$$

Frequency Spectrum of Amplitude Modulation:

[সামনে হবে]

Modulation Index or Modulation Depth Examples:-

Message signal এর যে Amplitude হবে তা অবশ্যই Carrier Signal থেকে ছোট হতে হবে।

⇒ The maximum amplitude of the carrier signal to avoid any distortion in the modulated signal.

For example:-

If the carrier signal amplitude is 5 volts then the message signal Amplitude must be less than (or equal to) 5 volts.

Hence, the maximum value of the

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CCE-2407 (Basic Communication Engineering)

Amplitude Modulation (AM) :- ~~(Baseband Signal)~~

Amplitude Modulation is a type of modulation where the amplitude (signal strength) of the carrier signal is varied in accordance with the amplitude (signal strength) of the message signal.

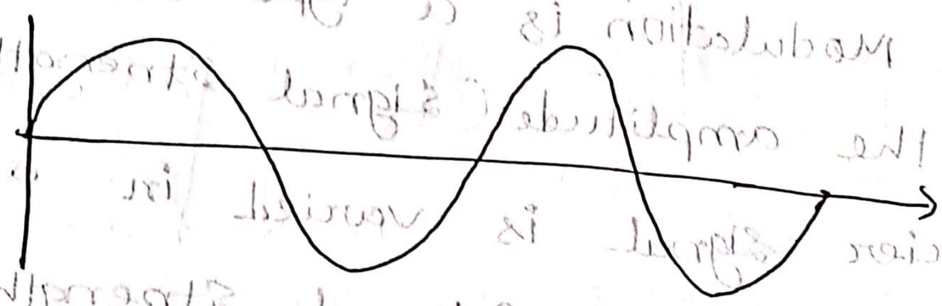
Or,

Amplitude Modulation is a type of modulation where the height of the carrier signal is changed in accordance with the height of the message signal.

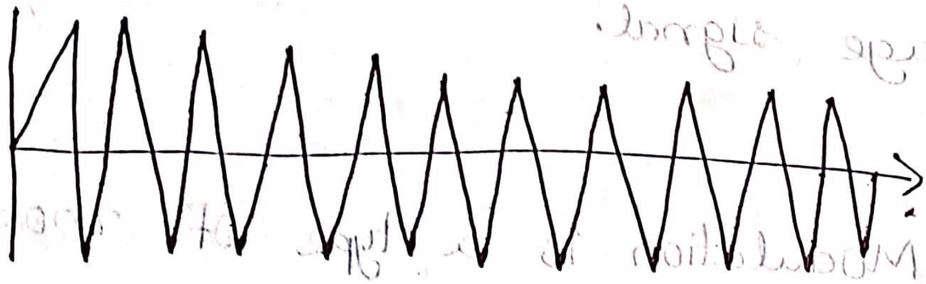
Standard Definitions:-

The amplitude of the carrier signal varies in accordance with the instantaneous amplitude of the modulating signal.

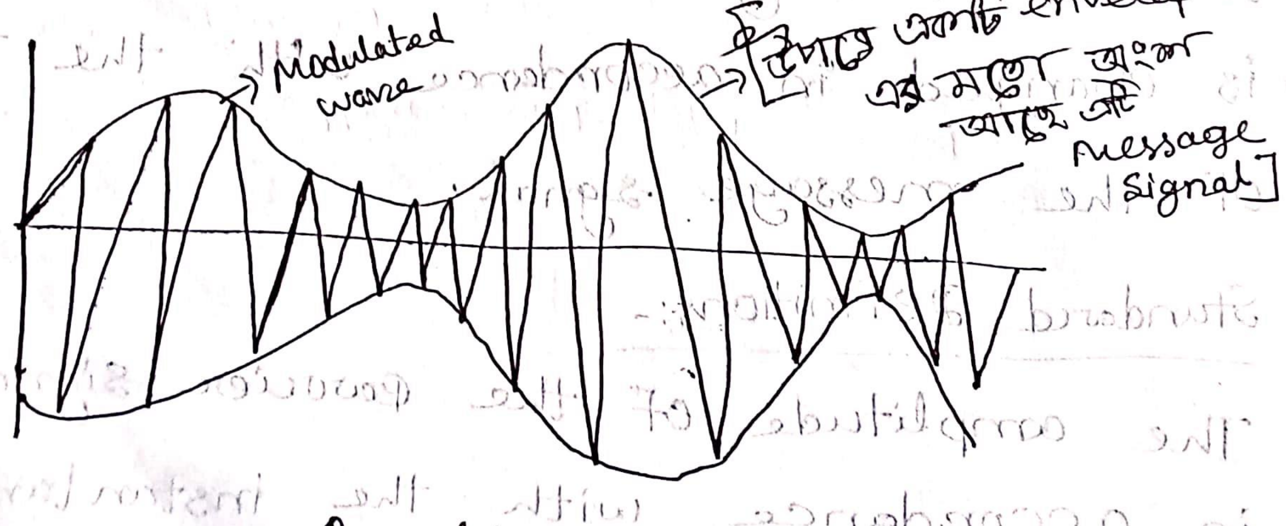
Means, the amplitude of the carrier signal ~~varies on~~ containing no information varies as per the amplitude of the signal information, at each instant.



- Message Signal



- Carrier Signal



- Amplitude Modulation (AM)

message Signal পরিবর্তন করা যাবে না
Carrier Signal " " " "

[PdF পড়তে হবে]

Mathematical Expression of AM:-

$a_m = A_m \sin \omega_m t$ —— (1) [message Signal] Equation

$a_c = A_c \sin \omega_c t$ —— (2) [Carrier Signal]

a_m = Moduling Signal of Message Signal

a_c = Carrier Signal

A_m = Maximum amplitude of the message signal

A_c = " " " " " Carrier Signal

ω_m = Frequency of the message signal

ω_c → " " " Carrier Signal

The Amplitude Modulated wave,

$$A = A_c + A_m \quad \text{—— (3)}$$

$$\Rightarrow A = A_c + A_m \sin \omega_m t \quad \text{—— (4)}$$

Modulation Index:-

Amplitude of the message signal & Carrier signal এর Ratio হচ্ছে Modulation Index।

~~$\Rightarrow a = A \sin \omega_c t$ — (5)~~

$\Rightarrow$ Amplitude Modulated wave,

$$a = A \sin \omega_c t \quad \text{—— (5)}$$

put a value from equation (4) into (5),

$$a = (A_c + A_m \sin \omega_m t) \sin \omega_c t \quad \text{—— (6)}$$

↳ This is an equation of Amplitude modula (AM) wave.

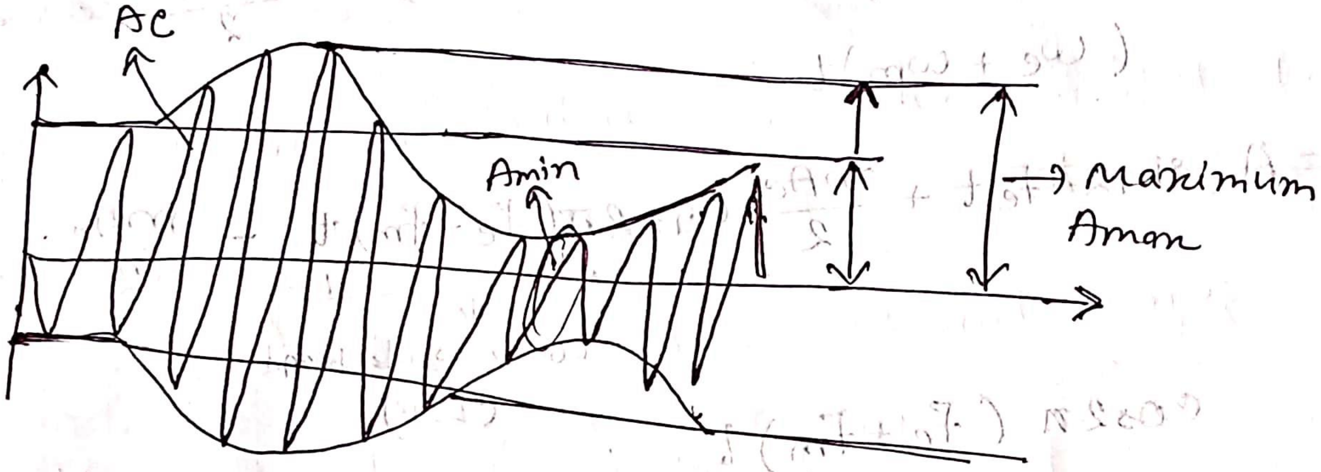
Frequency Spectrum বের করতে হলে।

$$AM(t) = (A_c + A_m \sin \omega_m t) \sin \omega_c t \quad [\text{value of } M]$$

$$= A_c \sin \omega_c t + m A_c \sin \omega_m t \sin \omega_c t$$

$$= A_c \sin \omega_c t + \tfrac{1}{2} \cdot 2 \cdot m A_c \sin \omega_m t \sin \omega_c t$$

1) Calculation of Modulation Index from Amplitude Modulated (AM) waveform:-



$$A_m = \frac{A_{max} - A_{min}}{2} \quad \text{—— (1)}$$

$$A_c = A_{max} - A_m \quad \text{—— (2)}$$

First Am value from eqn (1) into eqn (2),

$$A_c = A_{max} - \frac{A_{max} - A_{min}}{2} \quad \text{—— (3)}$$

$$A_c = \frac{A_{max} + A_{min}}{2} \quad \text{—— (4)}$$

$$M_I = \frac{A_m}{A_c}$$

$$M_i = \frac{\frac{A_{max} - A_{min}}{2}}{\frac{A_{max} + A_{min}}{2}}$$

$$= A_c \sin \omega_c t + \frac{mA_c}{2}\{\cos(\omega_c - \omega_m)t - \cos(\omega_c + \omega_m)t\}$$

$$= A_c \sin \omega_c t + \frac{mA_c}{2}\cos(\omega_c - \omega_m)t - \frac{mA_c}{2}\cos(\omega_c + \omega_m)t$$

$$= A_c \sin 2\pi f_c t + \frac{mA_c}{2}\cos 2\pi(f_c - f_m)t - \frac{mA_c}{2}$$

$\cos 2\pi(f_c - f_m)t$ → Lower Side Board (LSB)

$\cos 2\pi(f_c + f_m)t$ → Upper Side Bond (USB)

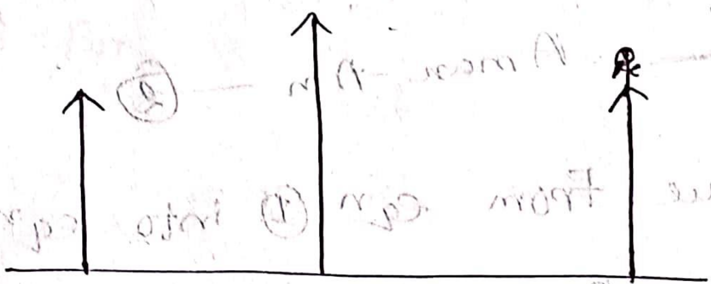


Fig: Frequency spectrum Representation of AM wave.

[Write The Equation & Figure of MA wave হলে উপরোক্ত চিত্র সহ লেখাগুলো লিখতে হবে] => Most Important (অবশ্য প্রাধান্যের হবে)