Final

Basics of Modulation :

Signal's properties

$A \cdot \cos(\omega t + \phi)$

↑ amplitude ↑ angular frequency ↑ Phase

(*) What is ~~data~~ Modulation :

Modulation is the process of changing the characteristics of a carrier signal w.r.t a message / modulating signal.

With respect to

Modulation ১ 2টি signal নিয়ে কাজ করি
i) carrier
ii) msg / modulating

Signal Properties
- Amplitude
- frequency
- phase

(*) Signals involved in the process of modulation :

1. Message / Modulating Signal:

Main data যেটা transmit করতে

It is an audio or video signal containing the necessary data or information to be transmitted.

- It is a low frequency signal.
- range : 20 Hz - 20 kHz

ii. Carrier Signal:

→ It is a high frequency signal with frequency range from 10k Hz to 3000 MHz whose characteristics such as amplitude, frequency or phase is altered w.r.t. the message (modulating signal.

(#) Basically message signal rides over carrier signal by the process of modulation.

Types of modulation

1) Amplitude Modulation, 2) Frequency Modulation,

3) Phase Modulation.

Why do we need modulation?

There are 4 reasons:

1) Frequency range and Energy,
2) Antenna length,
3) Wireless communication,
4) Interference.

1) Frequency range and Energy

- we know,

  Energy $\propto$ Frequency

- bcz, message signal,

  the frequency is low. since, we have low frequency, then we will get low energy content. It is ~~not helpful~~ not able to transmit the message signal in long distance.

2) Antenna Length

- For effective radiation of energy into space,
- the length of the antenna should be equal to the wavelength of the wave.

wave's speed = light's speed

$c = f\lambda$

$\lambda = \frac{c}{f}$

$= \frac{3 \times 10^8}{20}$

$= 15000$ km

$f_{min} = 20$ Hz

$f_{max} = 20$ kHz

$\lambda = \frac{3 \times 10^8}{20000} = 15$ km

Reasons of modulation

3. Wireless communication
4. Effects of ~~Interface~~ interference.

(3. Wireless communication)

⇒ Audio / Video Frequency signals or message signals need material medium for transmission. For this reason their transmission range is Low.

↓

twisted cable
copper cable

(A) carrier signal or radio ~~signal~~ frequency signals do not need any material medium for transmission. Since carrier signal has high frequency. so they have high energy components. As a result their transmission range is vast.

4. Effects of Interference

⇒ From electromagnetic wave theory, we can say that,

mutual interference is higher (noise distortion, Bit expectation : low) when the frequency of a signal is low and mutual interference is lower when the frequency of a signal is higher.

message signal

Q: mutual এর ... high হলে কি কি problem দেখা দিতে পারে?

↓

Solution

↓

modulation

↳ carrier signal

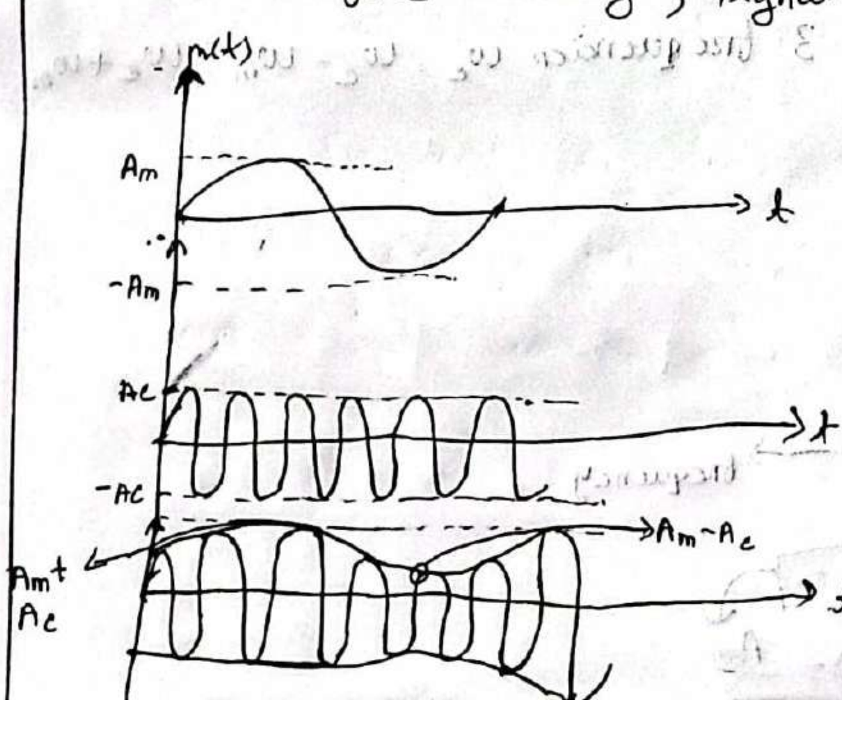
↳ frequency → high

↳ It will give us low interference → That should be our goal

Q. Reasons of modulation -এর ২টা technique

Amplitude modulation

It is the process in amplitude of carrier signal changes w.r.t. message (modulating) signal.



→ message signal, $m(t) = A_m \sin \omega_m t$ ~~Amplitude~~

→ carrier signal, $c(t) = A_c' \sin \omega_c t$

→ modulated signal, $s(t) = A' \sin \omega_c t$

$$y(t) = A' \sin \omega_c t$$

$$= (A_c + m(t)) \sin \omega_c t$$

$$= (A_c + A_m \sin \omega_m t) \sin \omega_c t$$

$$= A_c \left(1 + \frac{A_m}{A_c} \sin \omega_m t\right) \sin \omega_c t$$

$$= A_c (1 + M \sin \omega_m t) \sin \omega_c t$$

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

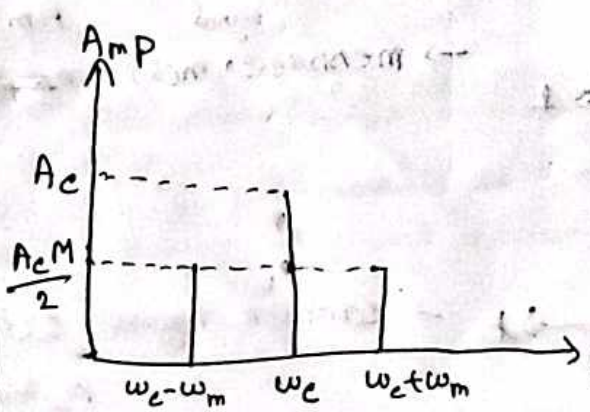
$$= A_c \sin \omega_c t + \frac{A_c M}{2} \cdot 2 (\sin \omega_c t \sin \omega_m t)$$

$$2 \sin A \sin B = \cos(A-B) - \cos(A+B)$$

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

side band

$y(t)$ → having 3 frequencies ω_c, $\omega_c - \omega_m$, $\omega_c + \omega_m$



Sideband - amplitude

$$\frac{A_c M}{2} = \left(\frac{A_c}{2} \times \frac{A_m}{A_c}\right) = \frac{A_m}{2}$$