12th April, 2018

Unit → 5

Fundamental Of Communication Engineering

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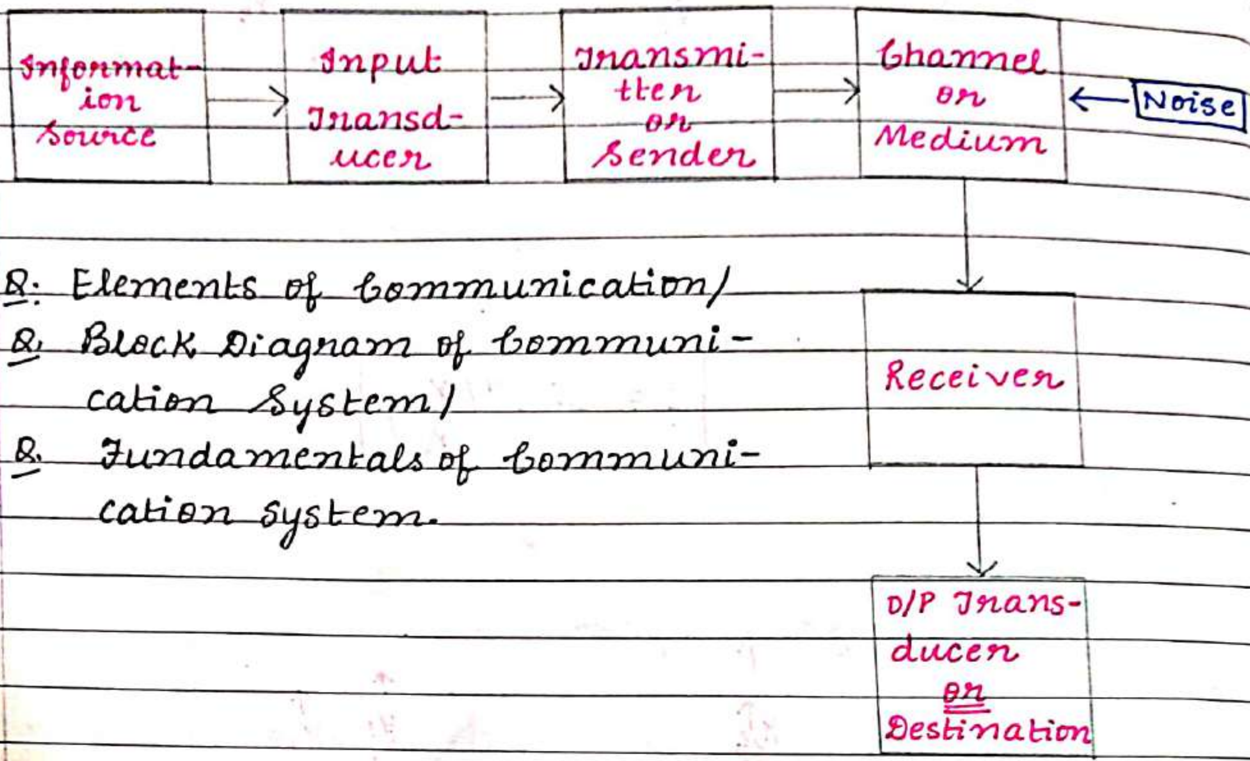


Q: Elements of Communication/

Q. Block Diagram of Communication System/

Q. Fundamentals of Communication system.

* Modulation :

{ Message signal / Modulating signal / Audio Signal / Base Band signal } Low frequency signal

{ Carrier Signal / Radio Signal } High frequency signal

Modulation is a process of mixing of high frequency signal with low frequency signal to transmit it to the greater distance.

- **Demodulation** : It is the process or technique to extract or recover the original information from the modulated signal by seperating the carrier.

- **Need of Modulation** :

(a) Increases the range of communication :

- At the low frequency, radiation is poor and signal gets highly attenuated, which will be reduced with the increase in frequency of transmitted signal.

- The frequency of Base Band signal or message signal is low. Hence, it cannot be transmitted over the long distance. Modulation process increases the frequency of the signal, hence, range of the communication also increases.

(b) Reduces the height of Antenna :

- For transmission of radio signal, the antenna height should be multiple of $\lambda/4$ where $\boxed{\lambda = \frac{c}{f}}$.

So, the minimum height of the Antenna will be –

$$\frac{\lambda}{4} = \frac{c}{4f}$$

For example – 10 KHz signal is transmitted

$$h_{min} = \frac{c}{4f} = \frac{3 \times 10^8}{4 \times 10 \times 10^3}$$

$$h_{min} = 7500\ m = 7.5\ Km$$ (but it is practically impossible)

Now, consider frequency of modulated signal is 10 MHz

$$h_{min} = \frac{\lambda}{4} = \frac{c}{4f} = \frac{3\times10^8}{4\times10\times10^6} = 7.5\,m$$

(c) Improves the quality of Reception :

With the help of modulation, the effect of noise is reduced to a great extent which improves the quality of receiving signal.

(d) Avoid the mixing of Signals :

If Base Band signals of the same frequency are transmitted then they may get mixed together at receiver's side, hence, by modulation process different carriers can be alloted to each signal which will avoid the mixing of signals.

(e) Allows the multiplexing of Signals :

Multiplexing is the process in which two or more signals can be transmitted over the same communication channel simultaneously which is possible only with the modulation.

(f) Allows the adjustments in the Bandwidth :

Bandwidth of modulated signal may be made smaller or larger than the original signal by the process of modulation.

instantaneous → at every point

v.v.v.v.v.imp

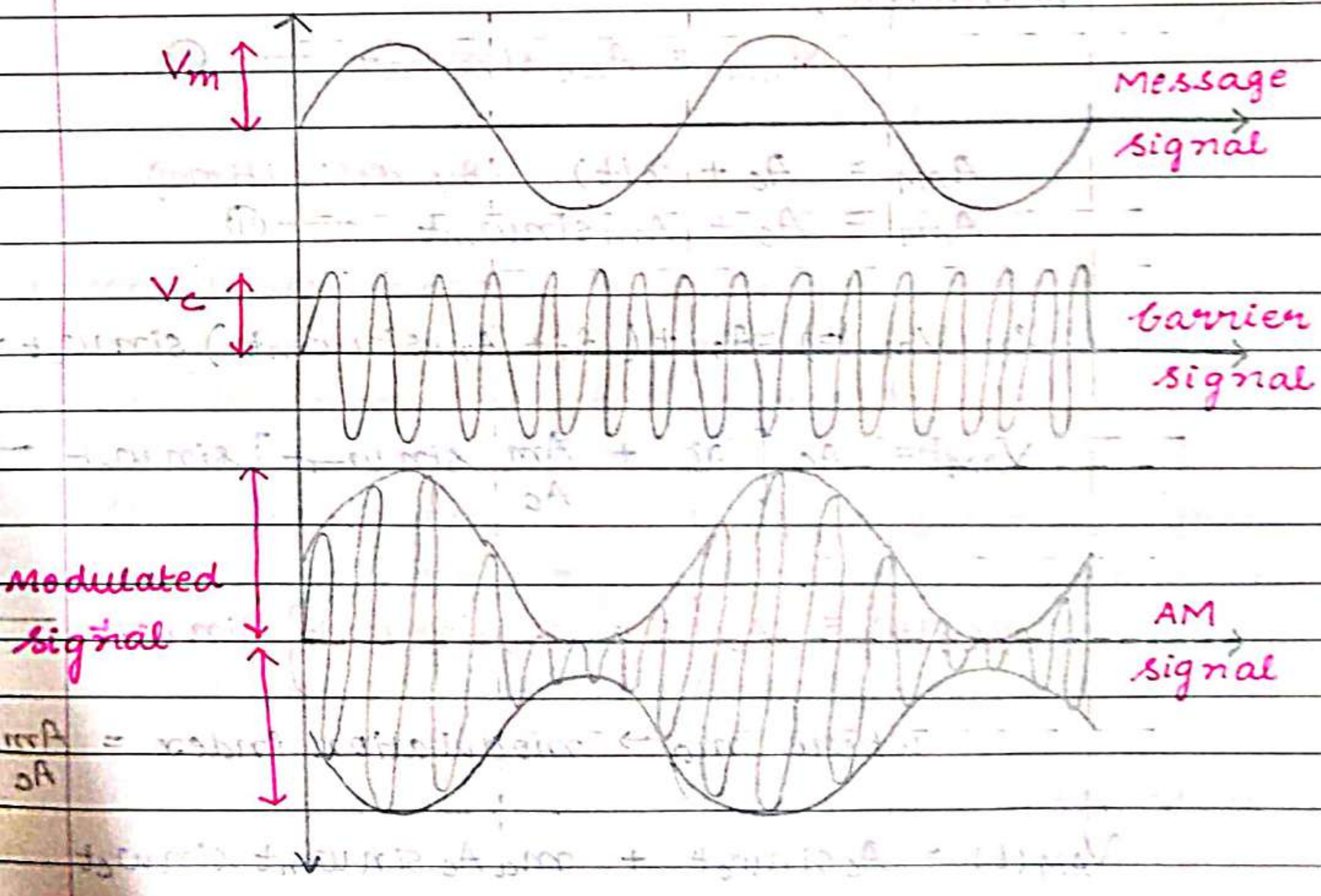
* Types Of Modulation :-

1) Amplitude Modulation (AM)
2) Frequency Modulation (FM)
3) Phase Modulation (PM)

1) ⇒ Amplitude Modulation (AM) :

When the Amplitude of carrier signal gets changed with respect to the instantaneous value of Base Band or Message Signal is called Amplitude Modulation.

{amplitude of carrier signal changes acc. to Base Band signal (at every value of base band or message signal}



Instantaneous value of message signal,

$$x(t) = A_m \sin \omega_m t \quad \text{—— ①}$$

A_m = Amplitude of message signal
ω_m = Angular frequency of message signal
f_m = frequency of message signal

Instantaneous value of carrier signal,

$$y(t) = A_c \sin \omega_c t \quad \text{—— ②}$$

A_c = Amplitude of carrier signal
ω_c = Angular frequency of carrier signal
f_c = frequency of carrier signal

Modulated,

$$V_{AM} = A_{AM} \sin \omega_c t \quad \text{—— ③}$$

$A_{AM} = A_c + x(t)$ (By definition)

$$A_{AM} = A_c + A_m \sin \omega_m t \quad \text{—— ④}$$

$$\therefore V_{AM}(t) = (A_c + A_m \sin \omega_m t) \sin \omega_c t \quad \text{—— ⑤}$$

$$V_{AM}(t) = A_c \left[1 + \frac{A_m}{A_c} \sin \omega_m t \right] \sin \omega_c t \quad \text{—— ⑥}$$

$$V_{AM}(t) = A_c \left[1 + m_a \sin \omega_m t \right] \sin \omega_c t \quad \text{—— ⑦}$$

where $m_a \rightarrow$ modulation index $= \frac{A_m}{A_c}$

$$V_{AM}(t) = A_c \sin \omega_c t + m_a A_c \sin \omega_m t \sin \omega_c t$$

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

$$\therefore V_{AM} = A_c \sin w_c t + \frac{m_a A_c}{2}\left[\cos(w_c - w_m)t - \cos(w_c + w_m)t\right]$$

$\cos\theta = \cos(-\theta)$

$$\boxed{V_{AM} = A_c \sin w_c t + \frac{m_a A_c}{2}\cos(w_c - w_m)t - \frac{m_a A_c}{2}\cos(w_c + w_m)t} \quad — (8)$$

carrier signal

Lower side band (LSB)

frequency LSB $= (f_c - f_m)$

Upper side Band (USB)

frequency USB $= f_c + f_m$

$$\frac{m_a A_c}{2} = \frac{A_m}{2} \quad \left[\because m_a = \frac{A_m}{A_c}\right]$$

$$A_{max} = A_c + A_m$$

$$A_{min} = A_c - A_m$$

- Modulation Index : It is the ratio between amplitude of message signal and amplitude of carrier signal which is given by $m_a = \frac{A_m}{A_c}$.

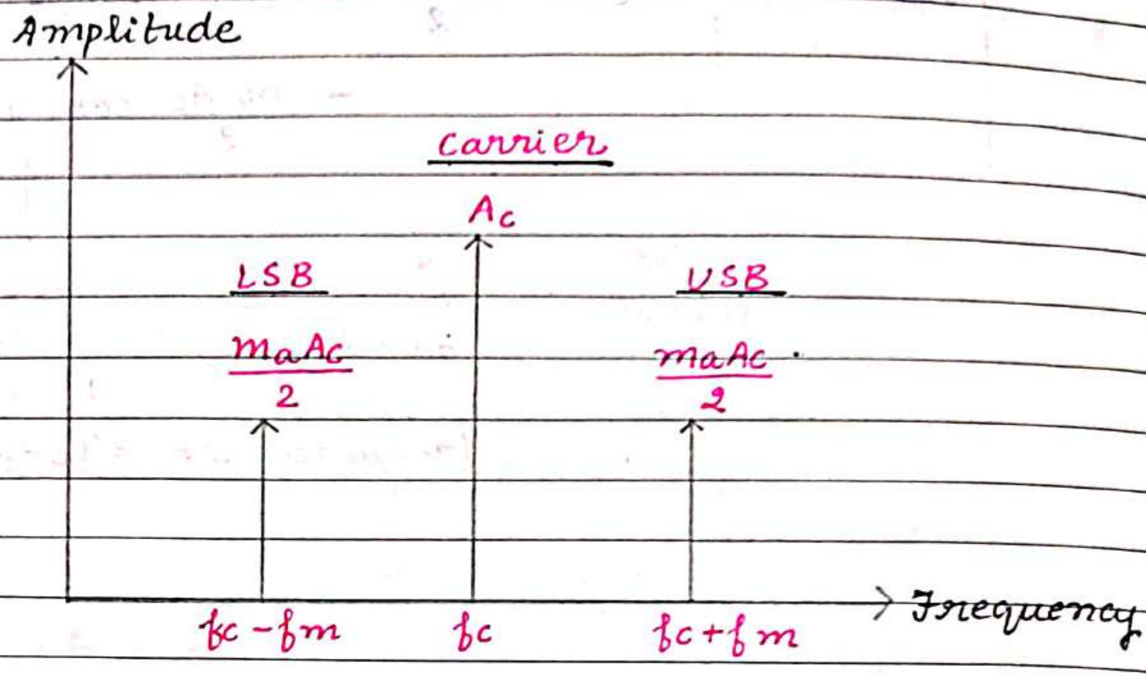
It is also known as Modulation factor, modulation coefficient, degree of modulation or depth of modulation.

In terms of maximum amplitude it is given as –

$$A_c = \frac{A_{max} + A_{min}}{2}, \quad A_m = \frac{A_{max} - A_{min}}{2}$$

$$\boxed{m_a = \frac{A_m}{A_c} = \frac{A_{max} - A_{min}}{A_{max} + A_{min}}}$$

- <u>Frequency Spectrum of AM signal</u> :-



- <u>Power Relations in AM</u> :-

$$P_{Total} = P_{carrier} + P_{LSB} + P_{USB}$$

$$P_{Total} = \frac{V^2_{carrier}}{R} + \frac{V^2_{LSB}}{R} + \frac{V^2_{USB}}{R}$$

All 3 are RMS value,

$$P_{Total} = \frac{\left(\frac{A_c}{\sqrt{2}}\right)^2}{R} + \frac{\left(\frac{\frac{m_a A_c}{2}}{\sqrt{2}}\right)^2}{R} + \frac{\left(\frac{\frac{m_a A_c}{2}}{\sqrt{2}}\right)^2}{R}$$

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

$$= \frac{Ac^2}{2R}\left[1 + \frac{ma^2}{4} + \frac{ma^2}{4}\right]$$

$$\boxed{P_{total} = \frac{Ac^2}{2R}\left[1 + \frac{ma^2}{2}\right]}$$

$$\boxed{P_{AM} = P_c\left(1 + \frac{ma^2}{2}\right)}$$

- **Total Power in Side Bands :**

$$P_{SB} = P_{side\ bands} = P_{LSB} + P_{USB}$$

$$= \frac{V^2_{LSB}}{R} + \frac{V^2_{USB}}{R}$$

All values are in RMS

$$= \frac{\left(\frac{\frac{maAc}{2}}{\sqrt{2}}\right)^2}{R} + \frac{\left(\frac{\frac{maAc}{2}}{\sqrt{2}}\right)^2}{R}$$

$$= \frac{ma^2Ac^2}{8R} + \frac{ma^2Ac^2}{8R}$$

$$= \frac{ma^2Ac^2}{4R}$$

Power of side bands $= \frac{Ac^2}{2R}\left(\frac{ma^2}{2}\right)$

$$\boxed{P_{SB} = P_c\left(\frac{ma^2}{2}\right)}$$

- Transmission Efficiency: Tramission efficiency of the AM wave is defined as the ratio of transmitted power ∴ contains information to the total power.

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

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

$$= \frac{m_a^2 \times \cancel{2}}{\cancel{2}(2+m_a^2)}$$

$$\boxed{\eta = \frac{m_a^2}{2+m_a^2}}$$

$$\boxed{\%\eta = \frac{m_a^2}{2+m_a^2} \times 100}$$

Ques Consider the AM signal $m(t) = 5[1+2\cos(2\pi \times 1000t)]\cos 2\pi \times 10^{60}$. Determine modulation index, side band frequencies, amplitude of each side band, total power when the resistance is 600 Ω and transmission efficiency.

Solⁿ $m(t) = 5[1+2\cos(2\pi \times 1000t)]\cos 2\pi \times 10^{60}$

$A_c = 5$

$m_a = 2$

$f_m = 1000$

$f_c = 10^{60}$

$$m_a = \frac{A_m}{A_c} \Rightarrow 2 = \frac{A_m}{5} \Rightarrow A_m = 10\ V$$

$$\therefore m_a = 2$$

Amplitude of LSB and USB $= \frac{m_a A_c}{2} = \frac{2 \times 5}{2} = 5\ V$.

$$\text{Total Power} = \frac{A_c^2}{2R}\left[1 + \frac{m_a^2}{2}\right]$$

$$= \frac{5^2}{2 \times 600}\left[1 + \frac{2^2}{2}\right]$$

$$= 0.0625\ \text{watt}$$

$$\eta = \frac{m_a^2}{2 + m_a^2} = \frac{2^2}{2 + 2^2} = 0.66$$

$$\%\ \eta = 0.66 \times 100 = 66.6\ \%$$

Ques The tunned circuit of the oscillator in a simple AM transmittor consists of a 50 uH coil and 1 nF, capacitor. If the oscillator output is modulated by audio frequency ~~upto~~ of 10 KHz. What is the frequency range occupied by the side bands?

$\cos 2\pi \times 10^{6} t$

Solⁿ $f_m = 10\ KHz$

$$f_c = \frac{1}{\sqrt{LC} \times 2\pi} = \frac{1}{\sqrt{50 \times 10^{-6} \times 1 \times 10^{-9}} \times 2\pi}$$

$$f_c = \frac{4.472 \times 10^6}{2\pi}$$

$$f_c = 711.76\ KHz$$

$$f_c + f_m = 711.76 + 10 = 721.76\ KHz$$

$f_c - f_m = 711.8 - 10 = \underline{\underline{701.8\ KHz}}$

Ques A sinosoidal carrier wave of freq. 1 MHz and amplitude 100 V is amplitude modulated by a sinosoidal ~~voltage~~ wave of 5 KHz producing 50% of modulation. Calculate the freq. and ampli. of LSB and USB.

Soln

$f_c = 1\ MHz$

$f_m = 5\ KHz$

$m_a = 50\% = \frac{50}{100} = \underline{\underline{0.5}}$

USB (frequency), $f_c + f_m = 1.005\ MHz$

LSB (frequency), $f_c - f_c = \underline{\underline{995\ KHz}}$

$\frac{A_m}{A_c} = m_a$, $A_c = 100\ V$

LSB and USB's amplitude $= \frac{m_a A_c}{2}$

$= \frac{0.5 \times 100}{2}$

$= \underline{\underline{25\ V}}$

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Ques A 400 W carrier is modulated to a depth of 75%. Calculate the total power and the side bands power.

Soln $P_c = 400\ W$

$m_a = \frac{75}{100} = 0.75$

$$\text{Total power} = P_c\left(1 + \frac{ma^2}{2}\right)$$

$$= 400\left(1 + \frac{(0.75)^2}{2}\right)$$

$$= 512.5 \text{ watt}$$

$$P_{SB} = P_c \times \frac{ma^2}{2} = 400 \times \frac{(0.75)^2}{2}$$

$$= 112.5 \text{ watt}$$

Ques A certain transmitter radiates 9 KW with carrier unmodulated and 10.125 KW when the carrier is sinosoidally modulated, calculate the modulation index. If another sine wave is simultaneously transmitted with modulation index 0.4. Determine the total radiated power.

Solⁿ (i) $P_c = 9 \text{ KW}$

$P_{total} = 10.125 \text{ KW}$

$$P_{total} = P_c\left(1 + \frac{ma^2}{2}\right)$$

$$\sqrt{\left(\frac{P_{total}}{P_c} - 1\right) \times 2} = ma$$

$$ma_1 = \sqrt{\left(\frac{10.125}{9 \times 10^3} - 1\right) \times 2}$$

$$ma_1 = 0.5$$

(ii) $ma_2 = 0.4$

$$ma = \sqrt{(ma_1)^2 + (ma_2)^2} = \sqrt{(0.5)^2 + (0.4)^2}$$

$$= 0.6403$$

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

$$= 9\left(1 + \frac{(0.64)^2}{2}\right)$$

$$= \underline{10.845\ KW}.$$

$$(m_a)_{total} = \sqrt{(m_{a1})^2 + (m_{a2})^2}$$

Ques The unmodulated RMS current of an AM wave is 8.93 Amp and increases to 11.25 Amp with modulation. Determine the modulation index.

Sol^n

$I_c = 8.93\ A$

$I_t = 11.25\ A$

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

$$I_t^2 \cancel{R} = I_c^2 \cancel{R}\left(1 + \frac{m_a^2}{2}\right)$$

$$(11.25)^2 = (8.93)^2\left(1 + \frac{m_a^2}{2}\right)$$

$$\underline{m_a = 1.08}$$

Bandwidth of AM wave $= (f_c + f_m) - (f_c - f_m)$

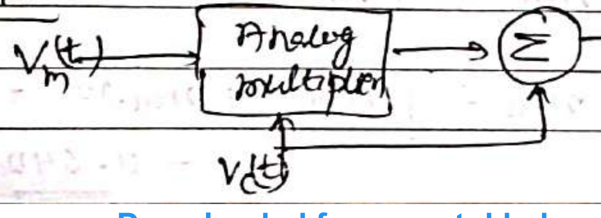
$$\boxed{BW = 2f_m}$$

(i) $m_a > 1$ i.e. $V_m > V_c$ = over modulation

(ii) $m_a < 1$ i.e. $V_m < V_c$ = under modulation

(iii) $m_a = 1$ i.e. $V_m = V_c \Rightarrow$ 100% modulation

Analog modulator



$V = V_c + V_m \cdot V_c$

$V = V_c(t) + V_m(t) \cdot V_c(t)$

16th April, 2018

* DSBSC (Double side band Suppressed Carrier):

$$V_{AM}(t) = V_c \sin \omega_c t + \frac{V_m}{2}\cos(\omega_c - \omega_m)t - \frac{V_m}{2}\cos(\omega_c + \omega_m)t$$

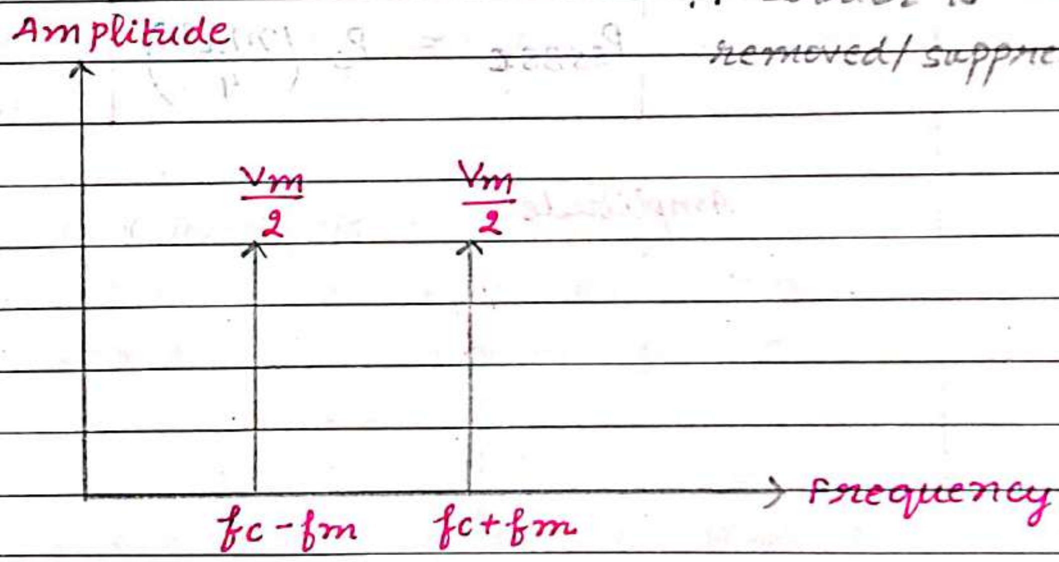
$$V_{DSBSC}(t) = V_{AM}(t) - V_c(t)$$

$$\boxed{V_{DSBSC}(t) = \frac{V_m}{2}\cos(\omega_c - \omega_m)t - \frac{V_m}{2}\cos(\omega_c + \omega_m)t}$$

$$\boxed{P_{DSBSC} = P_c\left(\frac{m_a^2}{2}\right) = \frac{V_c^2}{2R}\left(\frac{m_a^2}{2}\right)}$$

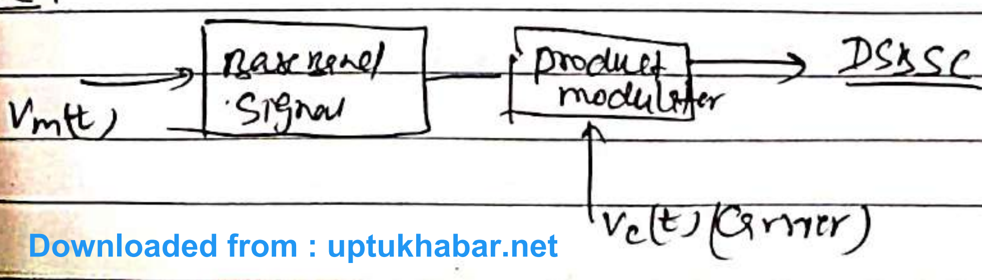
As carrier does not contain any message, the power is wasted ∴ carrier is removed/suppressed.

⇒ **Frequency Spectrum:**



$$\boxed{BW = 2f_m}$$

DSBSC:



Low Pass
High Pass
Band Pass
Band Reject } Filter

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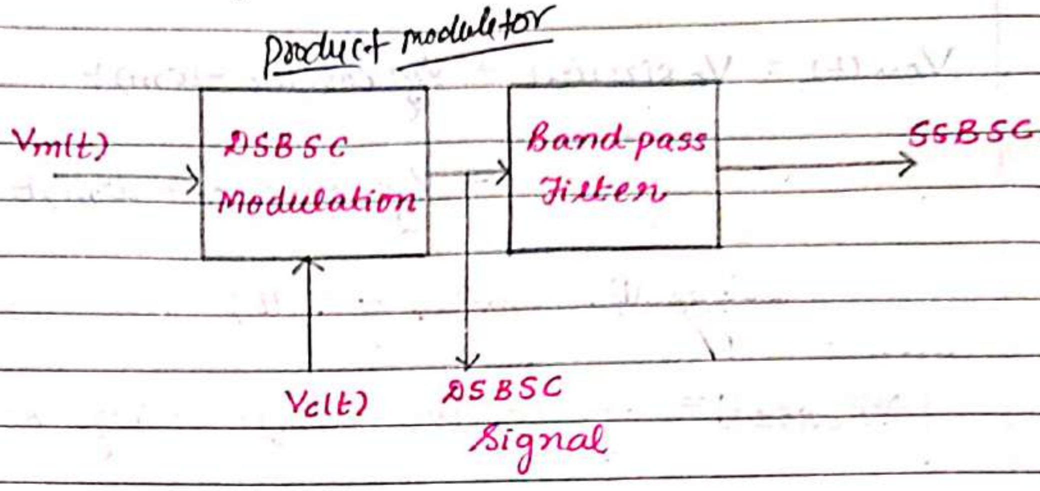
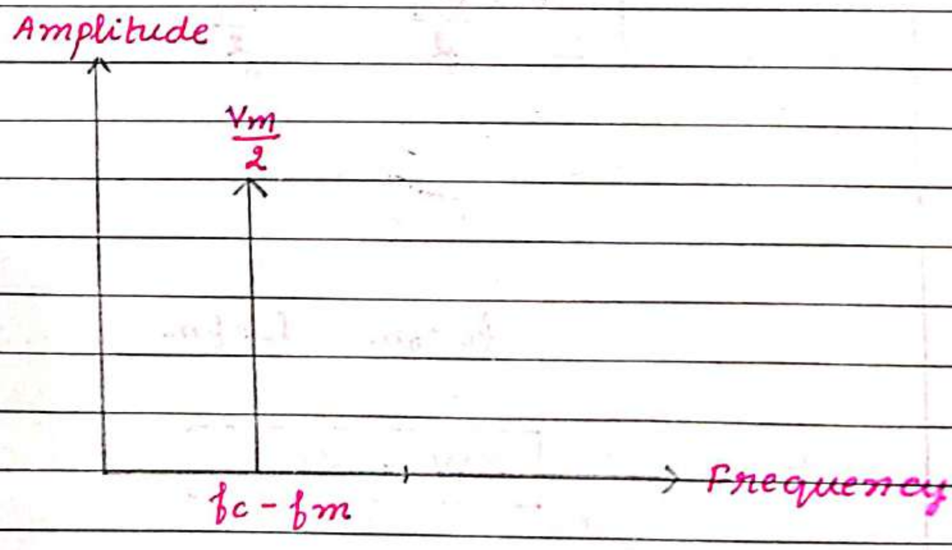
* SSBSC (Single Sideband Suppressed Carrier) :



$$V_{DSBSC}(t) = \frac{V_m}{2}\cos(\omega_c - \omega_m)t - \frac{V_m}{2}\cos(\omega_c - \omega_m)t$$

$$\boxed{V_{SSBSC}(t) = \frac{V_m}{2}\cos(\omega_c - \omega_m)t = \frac{V_m}{2}\cos(\omega_c + \omega_m)t}$$

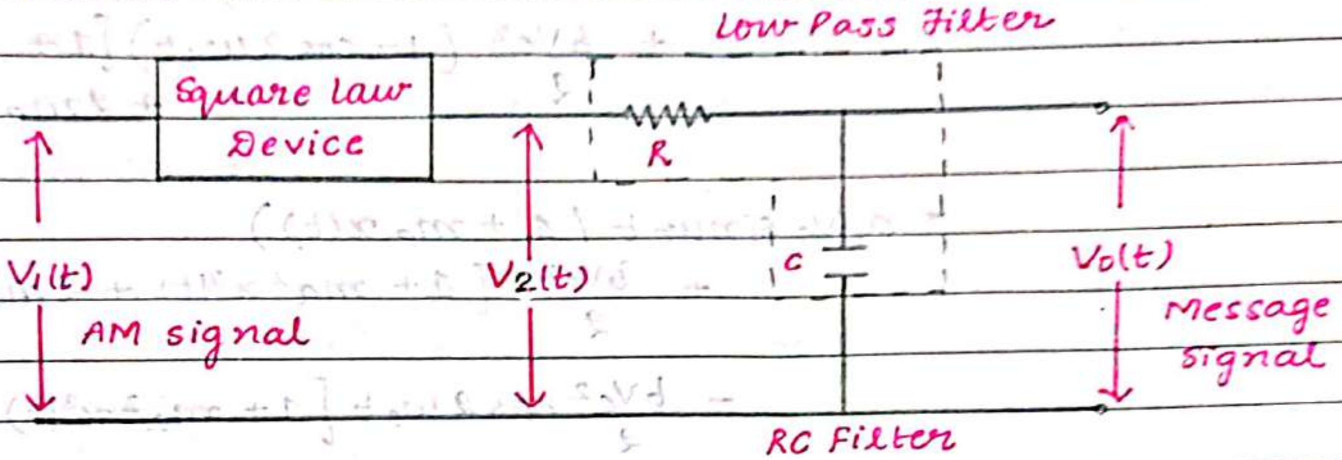
$$\boxed{P_{SSBSC} = P_c\left(\frac{m_a^2}{4}\right)}$$



* AM Detectors :- (or AM Demodulators)

1) Square law Detector
2) Envelope Detector

1) ⇒ SQUARE LAW DETECTOR :



The circuit diagram of a Square law Detector consists of a Square law Device which is a non-linear Device and low pass RC filter, shown in the figure.

⇒ Operation and Analysis :
The output of a Square law device is non-linear and it is expressed mathematically as

$$V_2(t) = a V_1(t) + b V_1^2(t) \quad \text{--- (1)}$$

So, the input to the square law detector is AM modulated wave which is given by -

$$V_1(t) = V_c[1 + m_a \sin w_m t] \sin w_c t$$

$$V_1(t) = V_c[1 + m_a x(t)] \sin w_c t \quad \text{--- (2)}$$

$x(t) \rightarrow$ message signal $= \sin w_m t$

On substituting eqn ② in ①,

$$V_2(t) = a_1[V_c(1+m_a x(t))\sin w_c t] + b V_c^2 \sin^2 w_c t\,(1+m_a x(t))^2$$

$$= a_1 V_c \sin w_c t\,(1+m_a x(t)) + \frac{bV_c^2}{2}(1-\cos 2w_c t)[1+m_a^2 x^2(t) + 2m_a x(t)]$$

$$= a_1 V_c \sin w_c t\,(1+m_a x(t)) + \frac{bV_c^2}{2}[1+\underbrace{m_a^2 x^2(t)}_{\text{sq. of L.F (not pass)}} + \underbrace{\boxed{2m_a x(t)}}_{\text{will pass}}]$$

Low Freq.

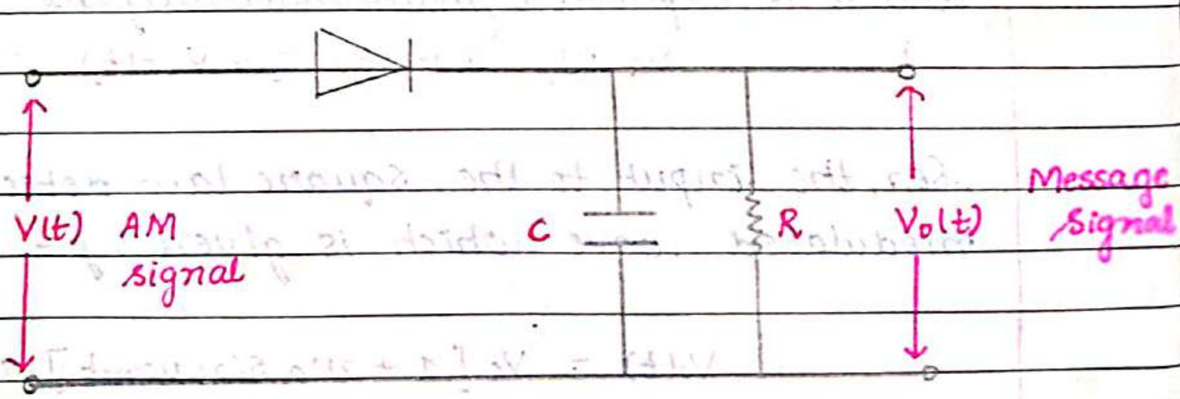
$$- \frac{bV_c^2}{2}\cos 2w_c t\,[1+m_a^2 x^2(t) + 2m_a x(t)]$$

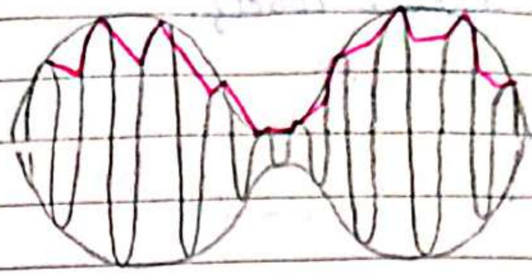
High Frequency Not pass

$$V_0(t) = \frac{bV_c^2}{2} \times 2m_a x(t)$$

$$\boxed{V_0(t) = bV_c^2 m_a x(t)}$$

2) ⇒ Envelope Detector :





⇒ The Envelope Detector is a very simple and effective device which suitable of detecting a narrow band AM signal.

⇒ The Envelope Detector produces the output signal that follows the envelope of the input AM signal exactly.

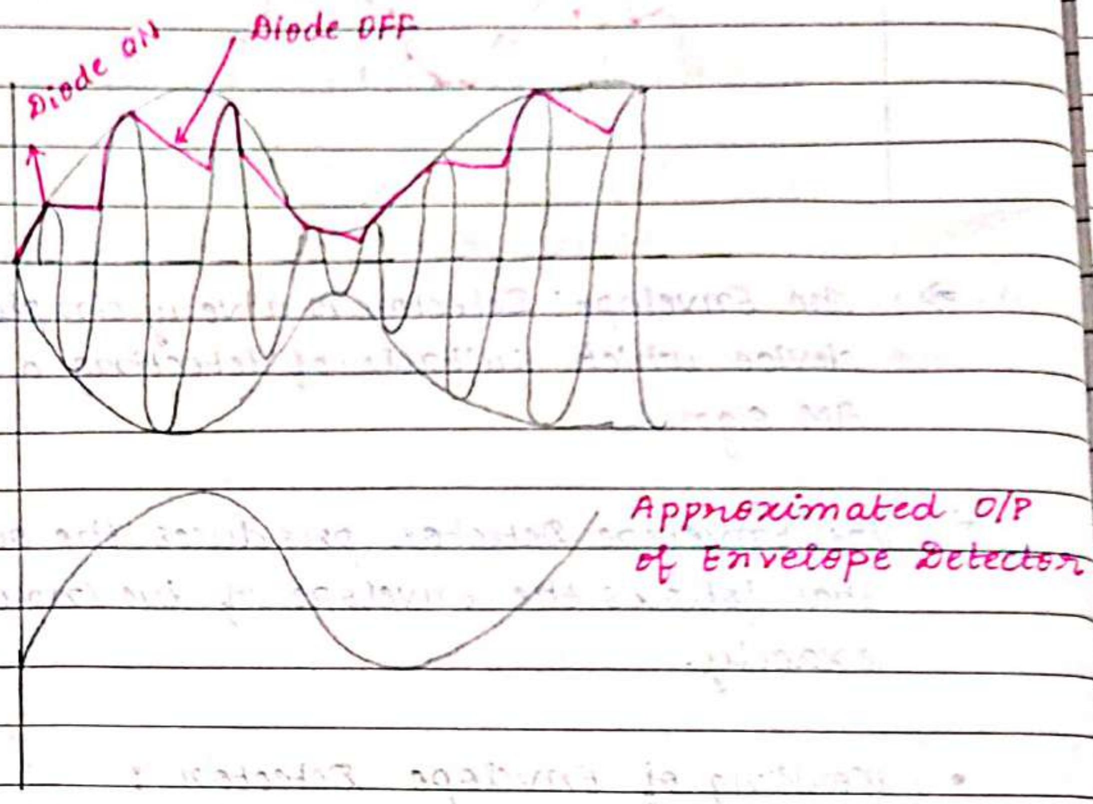
- Working of Envelope Detector :

⇒ The standard AM wave / signal is applied as a input to the Detector (Demodulator).

⇒ In every positive cycle of the input the detector diode becomes forward bias and charges the filter capacitor 'C' connected across the load resistor 'R' to the peak value of input signal.

⇒ As soon the capacitor charges to the peak value, the diode stops conducting and capacitor 'C' starts conducting between the positive peaks as shown in the waveform.

⇒ The discharging will continue until the next positive cycle and when the input signal becomes greater than the capacitor voltage, diode conducts again and the process repeats itself.



Also write 1-2 lines about waveform.

2) * ⇒ Frequency Modulation :

When the frequency of carrier signal gets changed with respect to the instantaneous value of Base Band or Message signal is called Frequency Modulation.

$V_m(t) = V_m \cos \omega_m t$ ⇒ Message signal —— ①

$V_c(t) = V_c \cos \omega_c t$ ⇒ Carrier signal —— ②

$V_{FM}(t) = V_c \cos \theta$ ⇒ FM signal —— ③

$$\boxed{f = f_c + K_f V_m \cos\omega_m t}$$ ⇒ From definition

Multiplying by 2π on both the sides,

$$2\pi f = 2\pi f_c + 2\pi K_f V_m \cos\omega_m t$$

$$\boxed{\omega = \omega_c + 2\pi K_f V_m \cos\omega_m t} \quad \text{--- (4)}$$

Integrating equ^n (4) w.r.t 't'

$$\omega t = \omega_c t + 2\pi K_f \times \frac{1}{\omega_m} \times V_m \sin\omega_m t$$

$$\theta = \omega_c t + \frac{2\pi K_f V_m \sin\omega_m t}{\omega_m}$$

$$\theta = \omega_c t + \frac{2\pi K_f V_m \sin\omega_m t}{2\pi f_m}$$

$$\boxed{\theta = \omega_c t + \frac{K_f V_m \sin\omega_m t}{f_m}}$$

Now, putting the value of θ in equ^n (3)

$$V_{FM}(t) = V_c \cos\left[\omega_c t + \frac{K_f V_m \sin\omega_m t}{f_m}\right]$$

$\frac{\delta}{f_m} =$ $\boxed{m_f = \frac{K_f V_m}{f_m}}$ ⇒ Modulation Index of FM

$\boxed{K_f V_m = \delta}$ ⇒ frequency deviation

$$\boxed{V_{FM}(t) = V_c \cos(\omega_c t + m_f \sin\omega_m t)}$$

Introduction to Networks & Data Communication-

Data Communication-

* When we communicate, we are sharing information. This sharing can be local or remote.
* local communication usually occurs face to face ~~which~~ while remote communication takes place over distance.

Means of communication (telephony, telegraphy television etc)

Data-

refers to facts, concepts & instructions.
In computer information systems data are represented by binary information units (or bits) produced & consumed in the form of 0s & 1s.

* Data Communication is the exchange of data (in the form of 0's & 1's) between two devices via some form of transmission medium

* Data communication is considered local if the communicating devices are in the same building or a similarly restricted geographical area & is considered remote if the devices are farther apart.

For data communication to occur, the communicating devices must be part of a communication system made up of a communication of H/W & S/W.

The effectiveness of a data communication system depends on three fundamental characteristics:

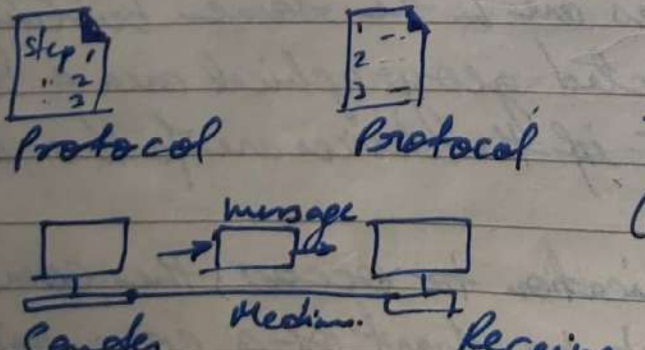
1) Delivery—
The system must deliver data to the correct destination. Data must be received by the intended device or user & only by that device or user.

2) Accuracy— The system must deliver data accurately. Data that have altered in transmission & left uncorrected & unusable.

3) Timeliness— The system must deliver data in a timely manner. Data delivered late are useless.
* In case of video, audio & voice data timely delivery means delivering data as they are produced in the same order that they are produced & without significant delay. This kind of delivery is called real-time transmission.

Data Communication System Components—

A DCN is made up of five Components



Message— is the information (data) to be communicated. It can consist of text numbers, pictures sound or video or any combination.

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Sender – is the device that sends the data message. It may be a computer, work-station, telephone handset, video camera & so on.

Receiver – is the device that receive the message. It can be a computer, workstation, telephone handset, TV & so on.

Medium – is the physical path by which a message travels from sender to Rx. It can be twisted pair wire, coaxial cable, fiber optic cable, laser or radio waves.

Protocol – is a set of rules that governs data communication. It represents an agreement between the communicating devices.

Line Configurations :–

1) Point to Point Connection –

* A P to P connection provides a dedicated link between two devices.
* Entire capacity of the link is reserved for for transmission between these two devices only.

Multipoint connection –

* In such a connection more two devices share a single link.
* In the multipoint connection the channel capacity is shared.

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Types of Communication: Simplex, Half Duplex, full Duplex:

1) Simplex Systems—

In these systems the information is communicated in only one direction.
Ex— TV broadcasting, radio
CPU to monitor, CPU to printer

2) Half Duplex Systems—

* These systems are bidirectional.
* They can transmit as well as receive but not simultanously.
* When one device is ending the other one is receiving & vice versa.

Full Duplex Systems—

* They allow the communication to take place in both the directions simultanously.

* These systems can transmit as well as receive simultaneously. for (Ex- telephone)

Computer Networks—

N/W is a communication system which supports many users.

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* Computer N/w is a system which allows communication among the computers connected in the N/w.

Distributed System:

* If one computer can forcibly start, stop or control another the computers are not autonomous.
* A system with one control unit & many slaves or a large computer with remote printers & terminal is not called a computer N/w, it is called a Distributed System.
* In distributed system the existence of multiple autonomous computers is not visible to the user.

Need of Computer N/w:-

i) Sharing the resources such as printers among all the users.
ii) Sharing of expensive s/w & database.
(iii) Communication from one computer to the other.
iv) Exchange of data & information amongst the users, via the N/w.
v) Sharing of information over the geographically wide areas.
vi) for connecting the computers between various buildings of an organization.
vii) for educational purposes.

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~~Comput~~ Components of a Computer N/w -

i) 2 or more computers.
ii) Cables as links b/w the computers.
iii) A NIC on each computer.
iv) Switches
v) A S/w called N/w operating system.

Benefits of Computer N/ws -

i) Increased Speed.
ii) Reduced Cost.
iii) Improved Security.
iv) Centralized S/w management.
v) E-mail
vi) Flexible access

Disadvantages of N/ws -

i) High cost of installation
ii) Requires time for administration
iii) failure of Server
iv) Cable faults

Computer N/w Criteria -

* N/w is a communication system which supports many users.

* A N/w must be able to meet certain

Date :
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criteria —

i) Performance —

performance can be measured in many ways —

a) in terms of transit time (the amount of time required for a message to travel from one device to the other.

b) Response time (the time between enquiry & response)

c) The other factors deciding the performance
1) No. of users 2) Type of transmission medium 3) Capacity of connecting H/w
4) Efficiency of S/w

d) Reliability (it decides the frequency at which N/w failure takes place.

e) Security —
protection of data from the unauthorized user or access.

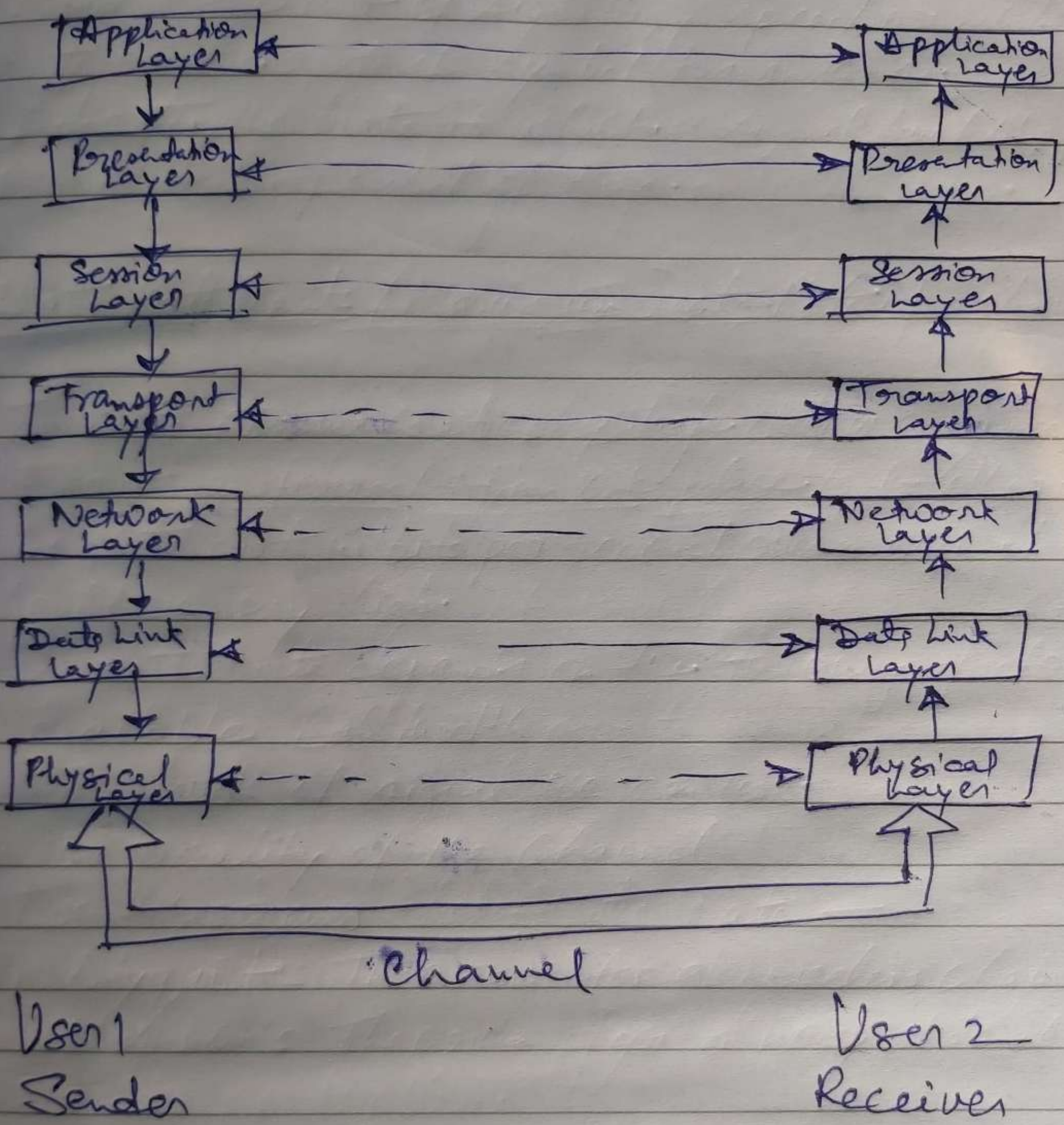
Uses of Computer Networks—

1) **Service Provided by the N/w for Companies—**

a) Resource Sharing
b) High reliability due to alternative sources of date
c) Money Saving
d) Communication medium

2) **N/ws for People—**

a) Access to remote information
b) Person to person communication
c) Interactive entertainment



The OSI Reference Model

Reference Model—

i) The OSI Ref. Model 2) The TCP/IP Ref.

(Open Source Interconnection) has been developed by ISO.

OSI Ref. Model - to ensure world wide data communication system compatible to each other, standards has been developed.

functions of Different Layers—

1) Physical Layer—

* To activate, maintain & deactivate the physical connection.
* define voltage & data rates needed for tx.
* To convert the digital bits into electrical S/g.

* To decide whether tx. is simplex, halfduplex full duplex.
* Exs of the physical layer protocol are RS-232 or RS-449 standards.

DLL -

* Synchronization & error control
* enable the error detection
* framming
* DLL ensures reliable tx. for each message.

(IEEE)

Exs of DLL protocols (HDLC, SDLC & X.25)

NL -

* To route the signal.
* packetizing
* responsible for m/c to m/c commn.

TL -

Model

* decides if the data transmission should take place on || path or singal path.
* Multiplexing, splitting or segmenting
* error control & flow control for process to process delivery.
* TL can be either connectionless or connection oriented.

SL -

* establishes, maintains & synchronises the interaction between communicating systems.

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* Session management (half duplex)
* check points.

*
Presentation Layer-
syntax & semantics of the information exchanged between 2 communication systems.
* Translation (ASCII or EBCDIC)
* encryption at tx & decryption at Rx.
* data compression.

AL-
* It provides services that directly support user application such as data base access, e-mail & file transfer.

TCP/IP Reference Model- (Transmission Control protocol/Internet protocol)
* This is the reference model which was used earlier by ARPANET & then it is being used in the Internet.

a research N/W sponsored by the US dept. of defence.

AL	TELNET, FTP, SMTP, DNS, HTTP, NNTP
TL	TCP, UDP
NL	IP
DLL	ARPANT, SATNET, LAN

Unit-1 Lecture-1

Introduction to Wireless Communication Systems →

The ability to communicate with people on the move has evolved.
Guglielmo Marconi first demonstrated radio's ability to provide continuous contact with ships sailing the English channel. That was in 1897 & since then new wireless communication methods & services have been adopted by people throughout the world.
Wireless comm has progressed through the development & deployment of radio, radar, TV, satellite & mobile telephone technologies.

Evolution of Mobile Radio Communications →

Evolution phase (i) The Pioneer-Phase (1921-1947)
Mobile telephone services began in 1940's (MTS Mobile telephone service). Also known as manual Telephone Systems as all calls are handled by operator.

* The early FM push-to-talk telephone systems of the late 1940's used 120 KHz for each channel of RF BW in a half-duplex mode; (ii) The Initial Commercial Phase (1946 — 1968)
* In 1946 the first public mobile telephone service was introduced in 25 major American cities.
* Each system used a single, high power transmitter & large tower to cover distances of over 50 km.
* The large RF Bandwidth was used because of the difficulty in mass-producing tight RF filters & low noise, front end receiver amplifiers.

In 1960s → IMTS (Improved Mobile Telephone System).

* With IMTS telephone companies began

Unit-1 Lecture-1

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In 1960s → IMTS (Improved Mobile Telephone System).
* With IMTS telephone companies began offering full duplex, autodial, autotrunking

* "Wireless Communication is simply a medium to communicate from one device to another device without having any physical link between them."

phone systems.

* IMTS used several carrier frequencies so several simultaneous mobile call can be handled.
* Directly can be dial from PSTN so operator eliminated.

IMTS & MTS T^x power → 100W to 200W range
Mobile Unit
MU T^xed power → 5W to 25W.
so they can cover a wide area using one 1 BS T^x.

<u>Limitation</u>-
high cost, limited availability & narrow frequency allocation.

<u>Today</u> – Mobile becomes portable.
" Mobile means moving at high speed such as in a boat, airplane or automobile. (iii) Cellular, Wireless 1990-2011 (Mobile Phone) Personal Comm.

<u>Bell laboratories</u> developed Cellular concept in 1960s & 1970s.

During 1950s & 1960s BL developed techniques of Cellular radiotelephony (the concept of breaking a coverage zone (mkt) into small cells, each of which reuse portions of the spectrum to ↑ spectrum usage at the expense of greater system infrast.

<u>In 1983</u> → The FCC (Federal Communication Commision) finally allocated 666 duplex channels (40 MHz of spectrum in the 800 MHz band each channel having a one way BW of 30 kHz for a total spectrum occupancy of 60 kHz for each duplex channel) for the U.S. Advanced Mobile Phone System

* In 1989, the FCC granted an additional 166 Channels (10MHz) to U.S. cellular service providers to accommodate the rapid growth & demand.
* In 1991, the first US Digital Cellular (USDC) system H/w was installed in major U.S. cities.
* The USDC standard (Electronic Industry Association Interim Standard IS-54 & later IS-136) allowed cellular operators to replace gracefully some single-user analog channels with digital channels which support three users in the same 30kHz BW.
* The capacity improvement offered by USDC is 3 times that of AMPS (advance mobile phone service) because digital Modulation, speech coding & TDMA are used in place of analog FM & FDMA.

* IS-136 will eventually be replaced by wideband CDMA technology. Given the rate of digital signal processing advancements, speech coding technology will increase the capacity the 6 users per channel in the same 30KHz BW within a few years.

* A cellular system based on CDMA (Code division multiple access) was developed by Qual comm, Inc & standardized by the TIA (Telecommunications Industry Association) as an IS-95.

Advantages -

*→ It supports a variable number of users in 1.25MHz wide channels using direct sequence spread spectrum.

* In AMPS system requires that the signal be at least 18 dB above the co-channel interference to provide acceptable call quality, CDMA systems can operate at much larger interference levels because of their inherent interference resistance properties.

* Capacity Improves →

The ability of CDMA to operate with a much smaller SNR than conventional narrowband FM technologies allow CDMA systems to use the same set of frequencies in every cell, which provides a large improvement in capacity.

* Unlike other digital cellular systems, the Qualcomm system uses a variable rate vocoder with voice activity detection which considerably reduces the required data rate & also the battery drain by the mobile transmitter.

In 1990's → new specialized mobile radio service (SMR) was developed to compete with US cellular radio carriers.

* By purchasing small groups of radio system licenses from a large number of independent private radio service providers throughout the country, Nextel & Motorola formed an extended SMR (E-SMR) network in the 800 MHz band that provides capacity & services similar to cellular.

* Using Motorola's integrated radio system (MIRS), SMR integrates voice dispatch, cellular phone service, messaging & data transmission capabilities on the same N/W.

In 1995 → Motorola replaced MIRS with the integrated digital enhanced Network.

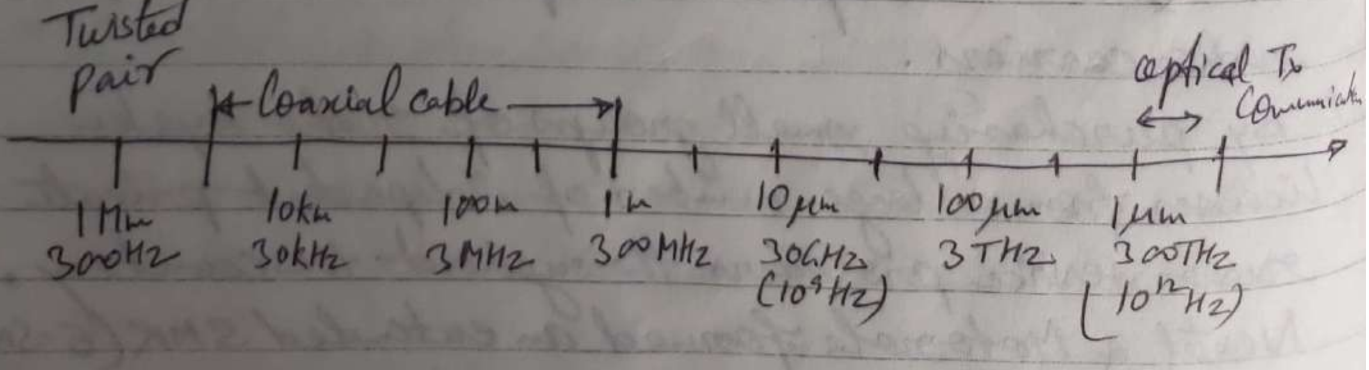
PCS (Personal Communication Service) licenses in the 1800/1900 MHz band.

Reasons for developing A Cellular Mobile Telephone System →

Limitations of Conventional mobile telephone system

(a) Limited Service Capability (No handoff)
(b) Poor service
(c) Inefficient frequency spectrum Utilization (No freq. reuse)
One large Power Tx is used.

frequency for Radio Tx communication →



The Duration of 1970-2011 may be subdivided in the form of Generations as —

The First Generation (1G) Analog Cellular Systems →

Main ch^{r}s of first generation systems are given as follows:

* Based on analog technology
* Use frequency modulation
* Its transport architecture has ~~to~~ the mobile Unit, the base station & mobile switching centre (MSC)
* Provides low rate data transmission between the base station & the mobile User.
* Speech signals are digitized on time division multiplexed format for transmission.
* This generation systems used FDMA technique in duplex mode.
* freq. band 800-900 MHz.

First Generation Systems

Name of the systems	Began	Country	Channel width (KHz)	Freq. Band (MHz)	No of Channel
NAMTS (Nippon Advanced mobile Tel. Service)	1978	Japan	25	870-885	600
NTT-900 (Nippon Telephone & Telegraph	1979	"	25	870-885 925-940	600
NMT-450 (Nordic Mobile Telephone	1981	Europe	25	453-457.5 463-467.5	180
AMPS (Advanced Mobile Phone Service	1983	N. America	30	825-845 870-890	666
TACS (Total Access Comm. System)	1985	Europe	25	890-945 935-960	1000 Plus
NMT-900	1986	"	12.5	890-915 935-960	1999

The each cell base-station is connected to Main Switching Center (MSC). The MSC is the master controlling switching center which provide interconnectivity between Public Switching Telephone N/W (PSTN) or (wired N/W) to cellular mobile N/W.

The Second Generation (2G): Digital Cellular Systems–

some advancement over 1G systems. Main features of 2G are

* All 4 types of information text, picture, data & voice are supported.
* Developed for digital cellular, mobile data & WLAN.

Several voice channels onto one carrier, therefore improving spectral utilization like FDMA/TDD
* Uses digital modulation techniques.
* More robust to interference.
* flexible BW.
* New services including authentication, data services, encryption of speech & data & other integrated services digital N/W (ISDN) capabilities as compare to Ist Gen services.
* Introduce the concept of base-station controller (BSC) over several base-station.
* More efficient, mobile controller handoff i.e. MAHO (mobile assisted handoff)
* Channel BW vaaried between 25-1250 kHz.
* CDMA was introduced at the end of ~~[illegible]~~ 2G.
* Bit rate adopted was higher with better error detecting capabilities.
* Some Important standards developed were GSM, IS-54, IS-95, JDC, NADC etc.

The Third Generation (3G) →

The migration to the 3G mobile system was to develop an ~~[illegible]~~ international standard to provide "any type of service, at any time, to any one & any where".
key features of 3G or IMT (International Mobile Telecommunication)-2000 are:

* High degree of interoperatibility
* Highly relaible services
* Global roaming facility
* Compatibility with all current standards
* Capability for multimedia applications including audio, video, text & data services.
* Wireless internet access upto 2Mbps.
* Use advanced time division multiple access (ATDMA), code division multiple access (CDMA), Collision sense multiple access (CSMA), spread spectrum & narrow-band digital frequency division multiple access (FDMA)

Examples of 3G systems are—
(i) IMT-2000 (ii) Universal Mobile Telecommunication System (UMTS) (iii) Mobile Broad band System (MBS) (iv) Wireless Local Area N/w (WLAN)

4G (fourth generation) MAGIC (Mobile Multimedia, anytime, anywhere, global Mobility support Integrated wireless solution & customised personal service)
peak download speed requirements for 4G service at 100 Mbit/sec for high mobility devices & 1 Gbit/sec for low mobility devices.

* flexible channel BW (5-20 MHz) optionally upto 40MHz.
* Smooth handoff across hetrogeneous N/ws.
* Seamless connectivity & global roaming multiple N/w

Benefits –

for Users – Select N/w depending on service requirements & cost

connect to any N/w – Worldwide roaming

• Access to New services.

for operation – Respond to variations in traffic demand (load balancing).

Incorporate service enhancement.

Rapid development of new personalised & customised services.

for manufacturers –

• Single platform for all markets.

• Increased flexible & efficient production.

Limitation of 4G →

(i) Mobile Station –

* Multimode User Terminals

* Wireless System Discovery.

* Wireless System selection.

(ii) System –

* Terminal Mobility

* N/w Infrastructure & QoS support.

* Fault Tolerance & Security.

(iii) Service –

Multi-operator & Billing System.

Personal Mobility

GSM (Global System for Mobile Communication)-

⇒ GSM is a digital mobile network that is widely used by mobile phone in Europe and other parts of the world.

⇒ GSM uses a variation of TDMA (Time Division multiple access) and is the most widely used of the three digital wireless telephony technologies- TDMA, GSM & CDMA (Code division multiple Access).

⇒ GSM digitizes and compresses data, then sends it down a channel with two other streams of user data, each in its own time slot.

⇒ It operates at either the 900 MHz or 1800 MHz frequency band.

⇒ GSM has maximum data speed of 5.6 kbit/sec and is based on circuit switching technology.

GPRS (General Packet Radio Service) →

⇒ GPRS will increase opportunities for higher revenues and enable new, differentiated services and tariff dimensions to be offered.

⇒ GPRS combines mobile access with Internet protocol based services, using packet data transmission that makes highly efficient use of radio spectrum and enables high data speeds.

It gives users increased BW, making it possible and cost-effective to remain constantly connected, as well as to send and receive data as text, graphics and video.

GPRS is a packet-based data bearer service for wireless communication services that is delivered as a network overlay for GSM, CDMA and TDMA.
GPRS data speeds will range from 14.4 kbit/s (using one radio timeslot) to 115 kbit/s and offer continous connection to the Internet for mobile phone and computer users.

GSM	GPRS
The frequency bands used in the system are 900 MHz and 1800 MHz that helps to identify the communication channels and manage the protocols associated.	There are 850, 900, 1800 and 1900 MHz to manage the system frequency and to support the communication. 850 and 1900 MHz is used in America and other frequencies in Europe, Asia, Africa and the middle East.
GSM is good at controlling circuit switching traffic and manages all the circuits in the network to control the traffic of the mobile devices.	GPRS is good at handling packets and even the data is transferred in the form of packets. Hence the traffic is also controlled as pkts and manages the pkts in the network of GPRS.
The location area concept is used so that the mobiles are traced and communicated with a location within the GSM network.	The routing area concept is used as the data is transferred as packets and these are used in the communication of the mobile devices.

It takes a long time to connect with any network through GSM as it has circuit switching and manages it through the symmetric mode of transmission. The data transmission is monitored and managed through circuits in the network.	A network connection is done faster in the system as packet data is used in GPRS. Data transmission through packets makes the system to manage the data and send messages in the asymmetric mode of transmission. The maximum speed is 114 kbps.
⇒ Internet service is not provided in GSM and this makes communication harder in the system. Communication has to be done through messages or calls.	⇒ Internet services are provided in GPRS and this is done with wireless systems. Hence the internet can be used even in remote areas and communication is done through emails or other messaging services with the internet.
GSM does not have GPRS incorporated in the system and hence it need not manage other services when GSM is in use. This makes communication simple.	GPRS incorporates GSM in the N/w but the communication is made simple by allowing GSM services even when the user is using GPRS services. Thus GPRS modifies GSM Network.
GSM provides its service in ~~GSM~~ all countries and remote areas.	GPRS services cannot be offered in all the countries and remote areas.
Single time slots are allowed per user in the system.	Multiple time slots are allowed to the user in the system and this makes the user use different applications at a time.

CODE DIVISION MULTIPLE ACCESS (CDMA).

Code division multiple access (CDMA) is a channel access method used by various radio communication technologies.
CDMA is an example of multiple access, where several transmitters can send information simultaneously over a single communication channel.
This allows several users to share a band of frequencies. To permit this without undue interference between the users, CDMA employs spread spectrum technology and a special coding scheme.
This Technology is commonly used in Ultra-high frequency (UHF) cellular telephone systems, bands ranging between the 800MHz – 1.9GHz.
Many different "signals" baseband with different spreading codes can be modulated on the same carrier to allow many different users to be supported. Using different orthogonal codes, interference between the signals is minimal.
Conversely when signals are received from several mobile stations, the base station is capable of isolating each as they have different orthogonal spreading codes.

CDMA Capacity – depends on
1) Processing Gain
2) Signal to Noise Ratio
3) Frequency Reuse Efficiency

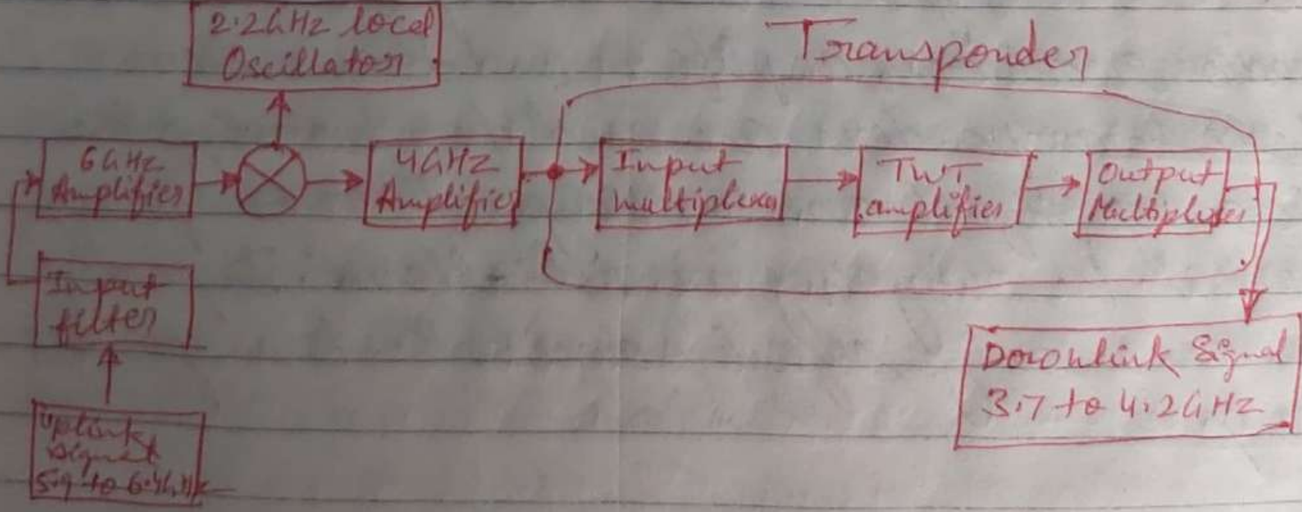
SATELLITE COMMUNICATION –

Satellite Communication is the method of transporting information from one place to another using a communication satellite in orbit around the Earth. A communication satellite is an artifical satellite that transmits the signal via a transponder by creating a channel between the transmitter and the receiver located at different locations on the Earth.

ELEMENTS OF SATELLITE COMMUNICATION –

Need for Satellite Communication →

There are different ways to communicate and the propagation of these ~~ways~~ waves can take place in different ways. Ground wave propagation and skywave propagation are the two ways in which communication took place for a certain distance. The maximum distance covered by them ~~by them~~ is 1500km and this was overcome by the introduction of satellite communication.

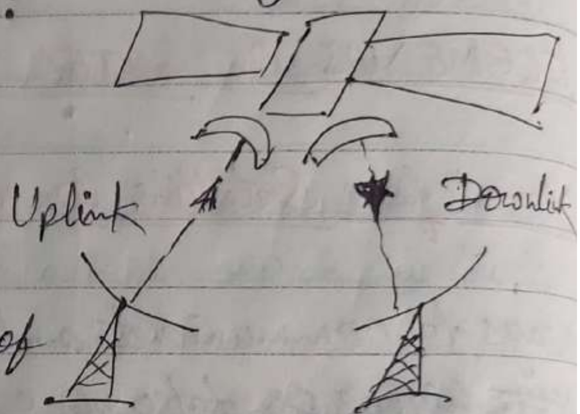


Element of Satellite Communication

How Satellite Communications Work?

The communication satellites are similar to the space mirrors that help us in bouncing the signals such as radio, internet data and television from one side of the earth to another. There are three stages that are involved which explain the working of satellite communications. These are:

→ Uplink
→ Transponders
→ Downlink



Let's consider an example of signals from a television.

In the first stage, the signal from the TV broadcast on the other side of the earth is first beamed up to the satellite from the ground station on the earth. This process is known as uplink.

The second stage involves transponders such as radio receivers, amplifiers and transmitters. These transponders are used for boosting the incoming signal and to change their frequency so that the outgoing are not altered. Depending on the incoming signal sources, the transponders vary.

The final stage involves a downlink in which the data is sent to the other end of the receiver on the earth. There is one uplink and multiple downlinks.

Advantages of satellite Communication:-

1) Installments of circuits are easy.
2) The elasticity of these circuits is excellent.
3) Using Satellite communication, every corner of the earth can be covered.
4) The user fully controls the Network.

Disadvantages of Satellite Communication-

1) Initial expenditure is high.
2) There are chances of blockage of frequencies.
3) Propagation and interference.

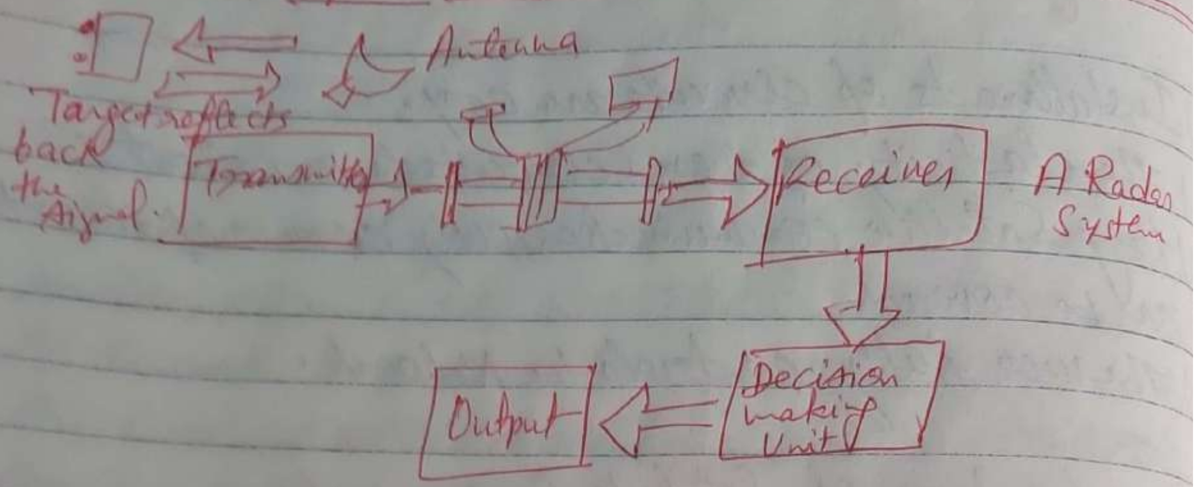
Application of Satellite Communication-

Telephone, Digital Cinema, Military, Television Radio Broadcasting, Internet access, Disaster Management

RADAR — (Radio Detection and Ranging System)

It is basically an electromagnetic system used to detect the location and distance of an object from the point where the RADAR is placed. It works by radiating energy into space and monitoring the echo or reflected signal from the objects. It operates in the UHF and microwave range.

Elements of RADAR Communication –



6 major elements of a Radar System –

Transmitter – it can be a power amplifier like a Klystron, Travelling Wave Tuble or a power Oscillator like a Magnetron. The signal is first generated using a Waveform generator and then amplified in the power amplifier.

Waveguides – are transmission lines for transmission of the RADAR signals.

Antenna – The antenna used can be a parabolic reflector, planar arrays or electronically steered phased arrays.

Duplexer – A duplexer allows the antenna to be used as a transmitter or a receiver. It can be a gaseous device that would produce a short circuit at the input to the receiver when transmitter is working.

Receiver – It can be super heterodyne receiver or any other receiver which consists of a processor to process the signal and detect it.

Threshold Decision → The output of the receiver is compared with a threshold to detect the presence of any object. If the output is below any threshold, the presence of noise is assumed.

Applications –

1) Military Applications
2) Air Traffic Control
3) Remote Sensing
4) Ground Traffic Control
5) Space