Course objective:

- ⇒ To learn modulation & its needs
- ⇒ To learn various modulation techniques
- ⇒ To learn telecommunication & Network fundamentals
- ⇒ To learn optical & satellite communication
- ⇒ To learn Cellular & Mobile communication & Wireless technologies

Course Outcomes:

- ⇒ To design simple modulated devices
- ⇒ To design AI devices
- ⇒ To design VOIP devices
- ⇒ To design advanced hybrid devices
- ⇒ To design latest technology devices / Machines

PEC

1. INTRODUCTION

Need for Modulation:

- Reduced height of Antenna
- Increase range of communication
- Avoid mixing
- perform multiplexing
- Improve quality of reception

Modulation: Msg + Carrier

The process of changing parameters of Carrier Signal with respect to message signal

- Message Signal / Information Signal / Low freq Signal
- Carrier Signal / High freq Signal

Spectrum: Group of frequency.

30 Hz - 300 Hz

300 Hz - 3 KHz

3 KHz - 30 KHz

30 KHz - 300 KHz

300 KHz - 3 MHz

3 MHz - 300 MHz

Frequency translation:

The process of converting one type of frequency to another type of frequencies is called as frequency translation.

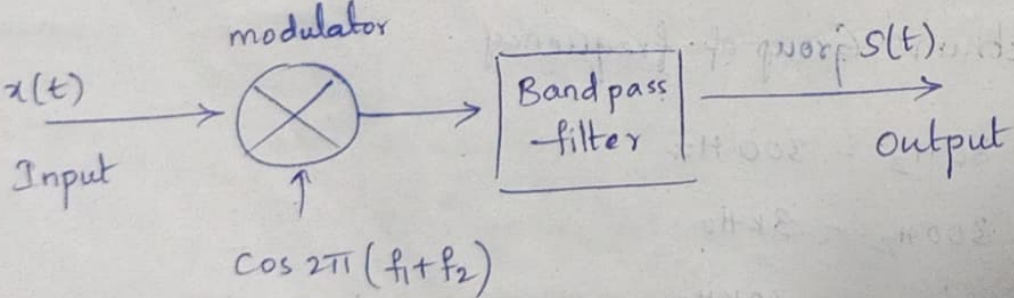
There are two types of frequency translations

1. Upfrequency translation
2. Downfrequency translation.

1. Upfrequency translation.

- The process of converting low freq values to high freq values
- In this process interpolation is used

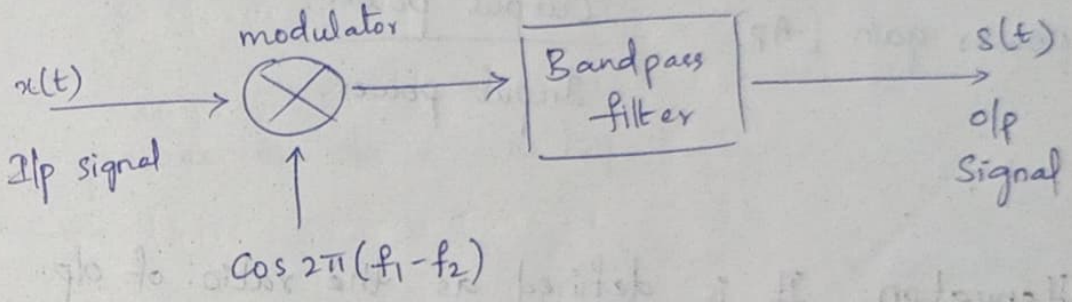
Interpolation - adding of frequencies



2. Down frequency translation:

- The process of converting high freq values to low freq values
- In this we use decimation process

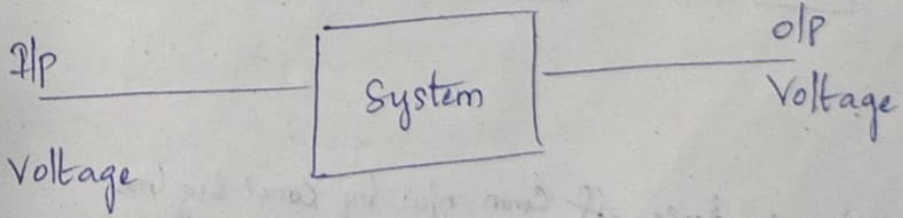
decimation - removing frequency



* Gain Attenuation Decibels:

Gain: It is defined as the ratio of o/p to the i/p

- Gain means 'amplification' or 'present'
- +ve values



- Amplyfng ws.
- long-dis cmm X losing data

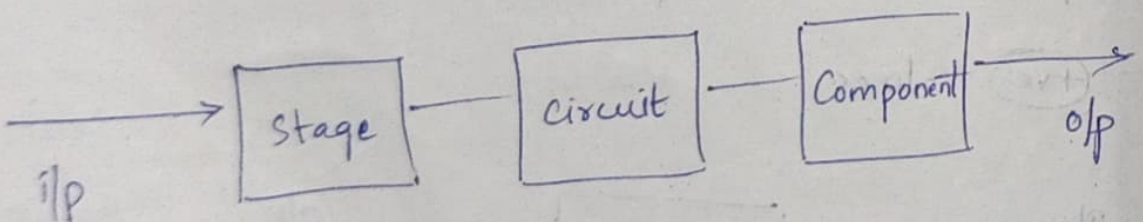
Voltage gain (A_V) = $\frac{\text{Output Voltage}}{\text{Input Voltage}}$

Current gain (A_I) = $\frac{\text{Output Current}}{\text{Input Current}}$

power gain (A_P) = $\frac{\text{Output power}}{\text{Input power.}}$

Attenuation: It is defined as the ratio of o/p Value to the i/p value

- Attenuation means 'loss' or 'absence'
- (-ve) Value



Helps in desig eff Cmm n/w by consi Sig loss req compensatg n/c

Decibels:

- It is a measuring quantity of gain & Attenuation
- Notation "dB"
- Voltage in dB = $20 \log \left(\frac{V_o}{V_i} \right)$

  Current in dB = $20 \log \left(\frac{I_o}{I_i} \right)$

  power in dB = $10 \log \left(\frac{P_o}{P_i} \right)$

- ref.

UNIT-1

problems

1. Calculate Voltage gain of an amplifier with i/p voltage 30 μv and o/p voltage 750mv.

Given data,

input voltage (V_i) = 30 μV = 30×10^{-6} V

Output Voltage (V_o) = 750 mV = 750×10^{-3} V

∴ Voltage gain of Amplifier

$$A_V = \frac{V_{out}}{V_{input}} = \frac{750 \times 10^{-3}}{30 \times 10^{-6}}$$

$$A_V = \frac{75}{3} \times 10^3$$

$$A_V = 25000 //$$

2. The o/p power of amplifier is given as 6 watts with a gain of 80 Calculate i/p power

Given data.

Output power (P_{out}) = 6W

power gain (A_P) = 80

Input power (P_{in}) = ?

∴ power gain (A_P) = $\frac{P_{out}}{P_{in}}$

$$P_{in} = \frac{6}{80}$$

$$P_{in} = 0.075 \text{ watts} //$$

3. Calculate o/p current of an amplifier having gain 100 with i/p current 5mA

Given data.

Input current (A_i) = 5mA = 5×10^{-3} A

Current gain (A_I) = 100

∴ Output current (I_o) = ?

∴ Current gain (A_I) = $\frac{I_{out}}{I_{in}} = \frac{I_o}{5 \times 10^{-3}}$

$$100 = \frac{I_o}{5 \times 10^{-3}}$$

$$\therefore I_o = 0.5 A //$$

4. For the given i/p & o/p, Justify that an amplifier having gain

a) input = 10V
Output = 100V

b) input = 100 watts
Output = 5 watts

a) Given data,

Input voltage (v_i) = 10V

Output voltage (v_{out}) = 100V

∴ Voltage gain in dB $(A_V) = 20\log_{10}\left(\frac{V_o}{V_i}\right)$

$$A_V = 20\log_{10}\left(\frac{100}{10}\right)$$

$$A_V = 20\log_{10}10$$

$$\boxed{A_V = 20\,dB}$$

∴ The amplifier having gain

b) Given data.

Input power $(P_i) = 100$ watts

output power $(P_{out}) = 5$ watts

∴ power gain in dB $(A_P) = 10\log\left(\frac{P_o}{P_i}\right)$

$$A_P = 10\log\left(\frac{5}{100}\right)$$

$$A_P = 10\log\left(\frac{1}{20}\right)$$

$$\boxed{A_P = -13.01\,dB}$$

∴ The amplifier having attenuation

5. The power amplifier with 40dB gain has an o/p of 100 watts Calculate i/p power.

Given data:

input power (P_i) = ?

Output power (P_o) = 100 watts

∴ power gain in dB = (A_P) = 40dB

$$A_P = 10 \log_{10}\left(\frac{P_{out}}{P_{in}}\right)$$

$$40 = 10 \log_{10}\left(\frac{100}{P_i}\right)$$

$$\frac{40}{10} = \log_{10}\left(\frac{100}{P_i}\right)$$

$$4 = \log_{10}\left(\frac{100}{P_i}\right)$$

Take Anti log

$$10^4 = \frac{100}{P_i}$$

$$P_i = \frac{100}{10^4}$$

$$P_i = \frac{100}{10000}$$

$$P_i = 10\,mw \Rightarrow 0.01\,watts$$

** In an amplifier with gain 25 DB. Calculate o/p values for the given i/p values

Input

a) 40V

b) 25A

c) 50 watts

a) input voltage (V_i) = 40 V

output voltage (V_o) = ?

$$25 = 20 \log_{10}\left(\frac{V_{out}}{V_{in}}\right)$$

$$25 = 20 \log_{10}\left(\frac{V_o}{40}\right)$$

$$\frac{25}{20} = \log_{10}\left(\frac{V_o}{40}\right)$$

$$\frac{5}{4} = \log_{10}\left(\frac{V_o}{40}\right)$$

$$10^{5/4} = \frac{V_o}{40}$$

$$V_o = \frac{10^{5/4} \times 40}{40}$$

$$\boxed{V_o = 711.3\,V}$$

b) input current (I_i) = 25 A

output current (I_o) = ?

$$25 = 20 \log_{10}\left(\frac{I_o}{I_i}\right)$$

$$25 = 20 \log_{10}\left(\frac{I_o}{25}\right)$$

$$\frac{25}{20} = \log_{10}\left(\frac{I_o}{25}\right)$$

$$\frac{5}{4} = \log_{10}\left(\frac{I_o}{25}\right)$$

$$10^{5/4} = \frac{I_o}{25} \Rightarrow \boxed{I_o = 10^{5/4} \times 25 = 444.5\,A}$$

c) Input power (P_I) = 50 watts

output power (P_o) = ?

$$25 = 10 \log_{10}\left(\frac{P_o}{P_I}\right)$$

$$\frac{25}{10} = \log_{10}\left(\frac{P_o}{50}\right)$$

$$\frac{5}{2} = \log_{10}\left(\frac{P_o}{50}\right)$$

$$10^{5/2} = \frac{P_o}{50}$$

$$P_o = 10^{5/2} \times 50 = 15811.3 \text{ watts}$$

2. Simple Description on Modulation

Modulation: The process of changing parameters of carrier signal w.r.t message signal.

Types of Modulation:

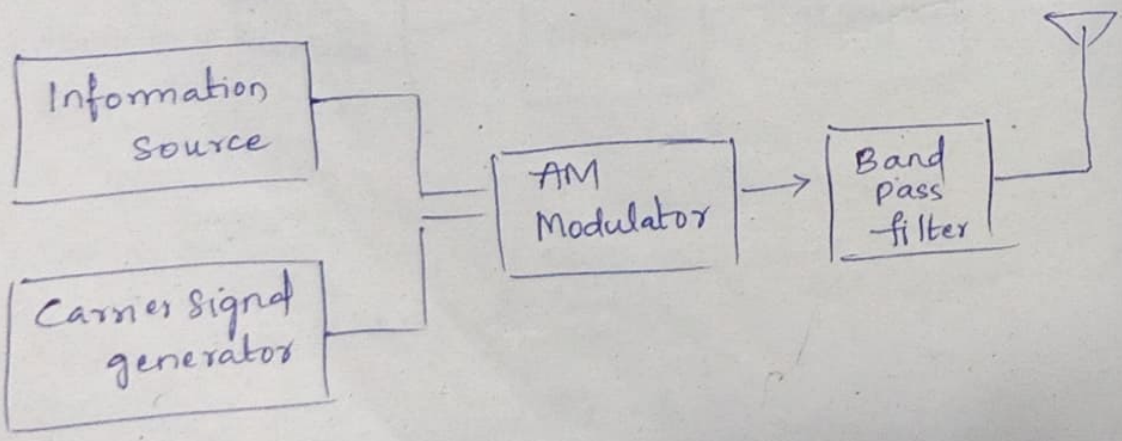
Based upon carrier signal parameters there are 3 types of Modulations:

Analog Modulations:

1. Amplitude modulation (AM)
2. Frequency modulation (FM)
3. phase modulation (PM)

1. Amplitude modulation (AM):

The process of changing amplitude of carrier signal w.r.t amplitude of information signal



Operation:

1. The Information Source generates msg signal or information signal with freq 'fm' i.e.,

$$m(t) = Am \cdot \cos 2\pi fmt$$

where, Am – Amplitude of msg signal

fm - freq of msg signal.

2. Carrier signal generator generates Carrier Signal or high frequency signal with frequency 'fc'

i.e., $c(t) = Ac \cdot \cos 2\pi fct$

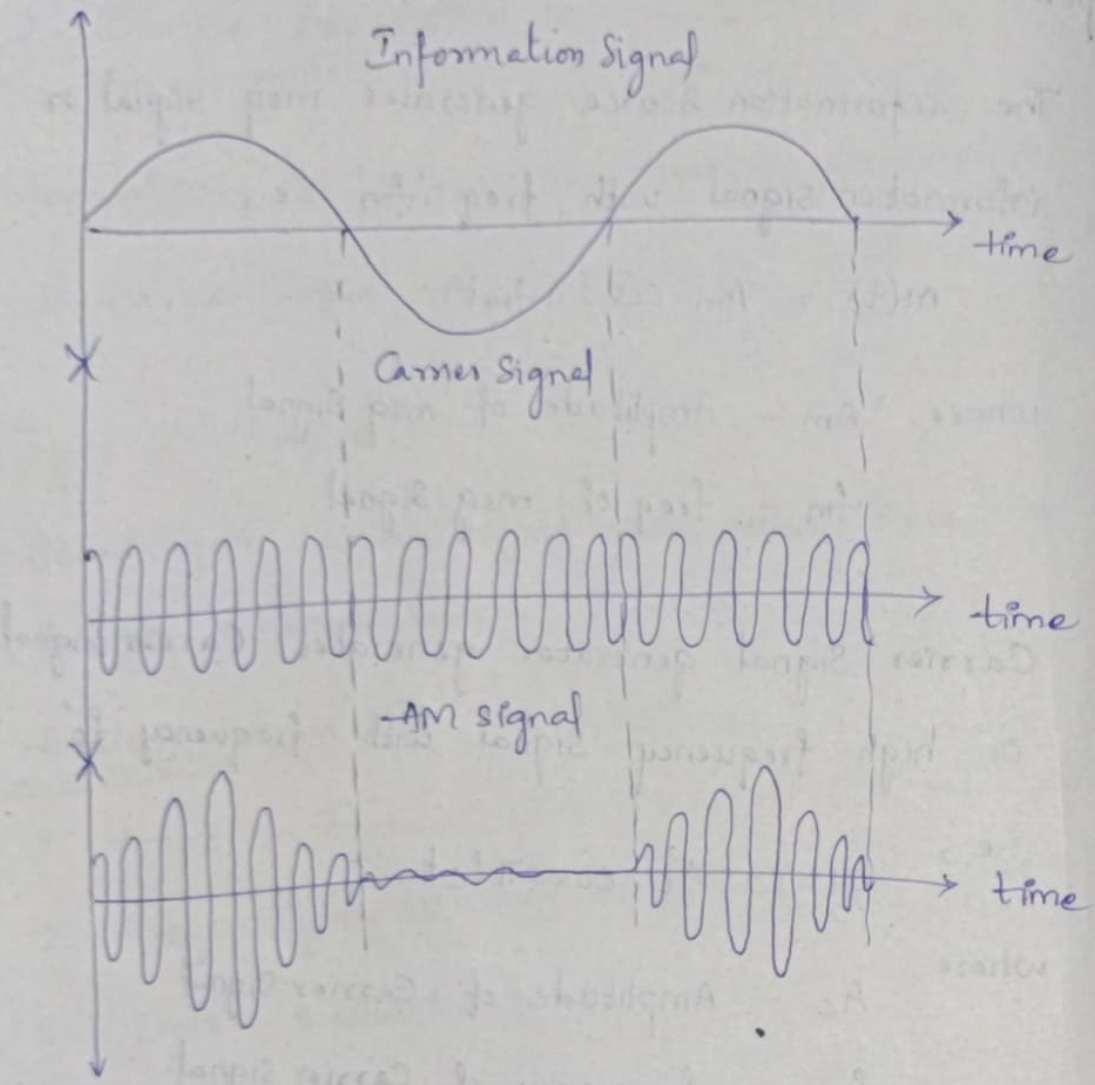
where,

Ac – Amplitude of Carrier Signal

fc : frequency of Carrier Signal

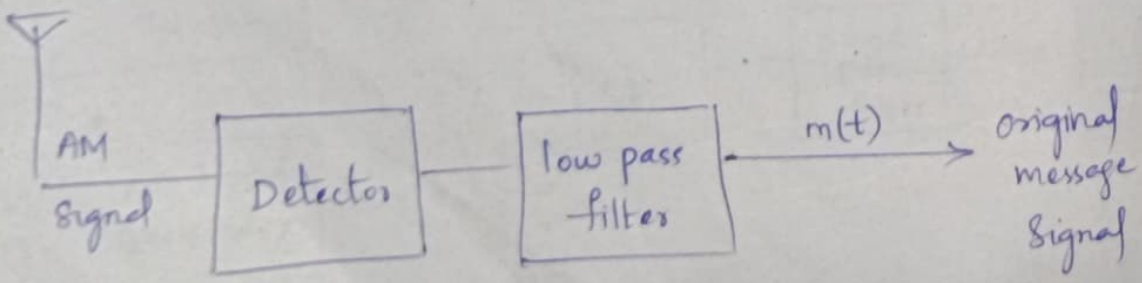
3. By using message & carrier modulator produce AM Signal

4 By using Bandpass filter it will transmits



AM demodulation:

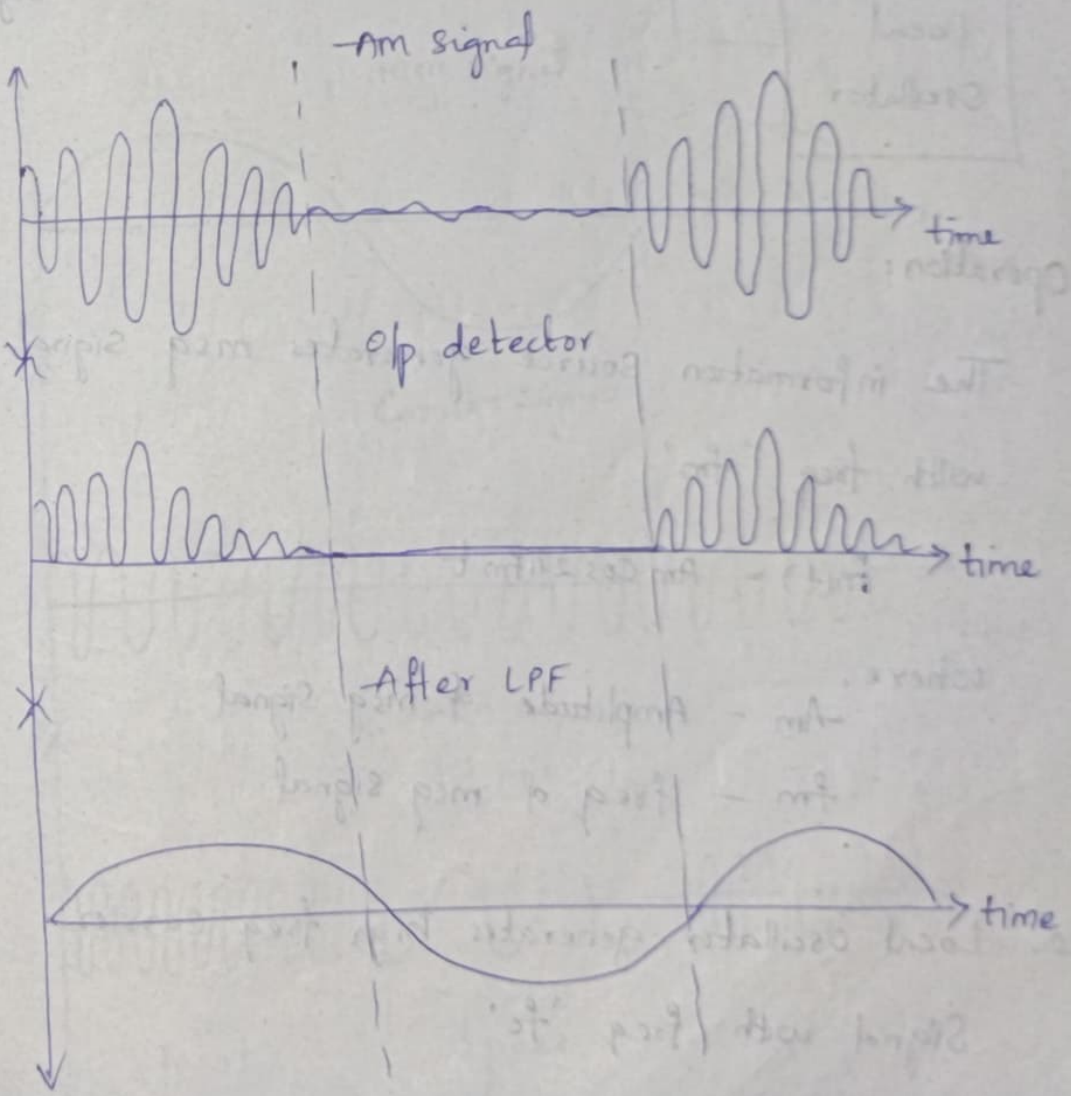
The process of removing Carrier Signal from modulated Signal



Operation:

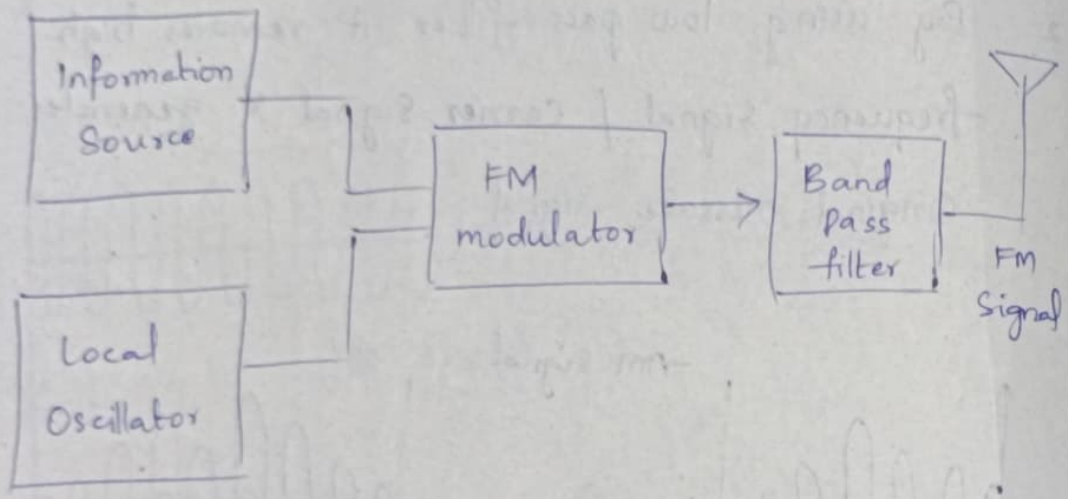
1. Whenever, a AM signal is given to a detector it conducts only for half cycle (+ve) and generates o/p signal

2. By using low pass filter it removes high frequency signal / carrier signal & generates Original message signal



2. Frequency Modulation (FM):

The process of changing frequency of a carrier signal w.r.t amplitude of message signal



Operation:

1. The information source generates msg signal with freq 'fm'

$$m(t) = A_m \cos 2\pi f_m t$$

where.

A_m - Amplitude of msg signal

f_m - freq of msg signal

2. Local oscillator generates high freq carrier signal with freq 'fc'

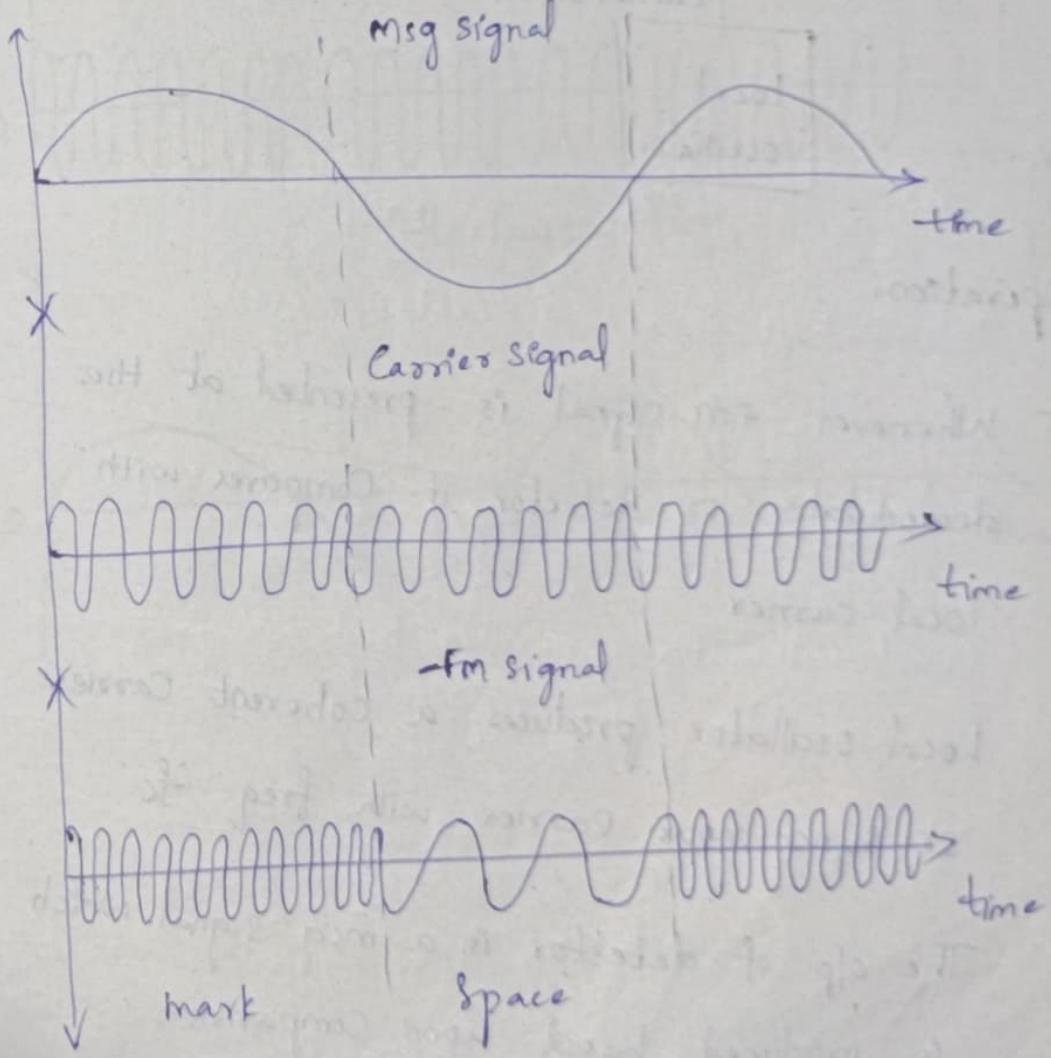
$$C(t) = A_c \cos 2\pi f_c t$$

where,

- Ac - Amplitude of carrier signal
- fc - freq of carrier signal

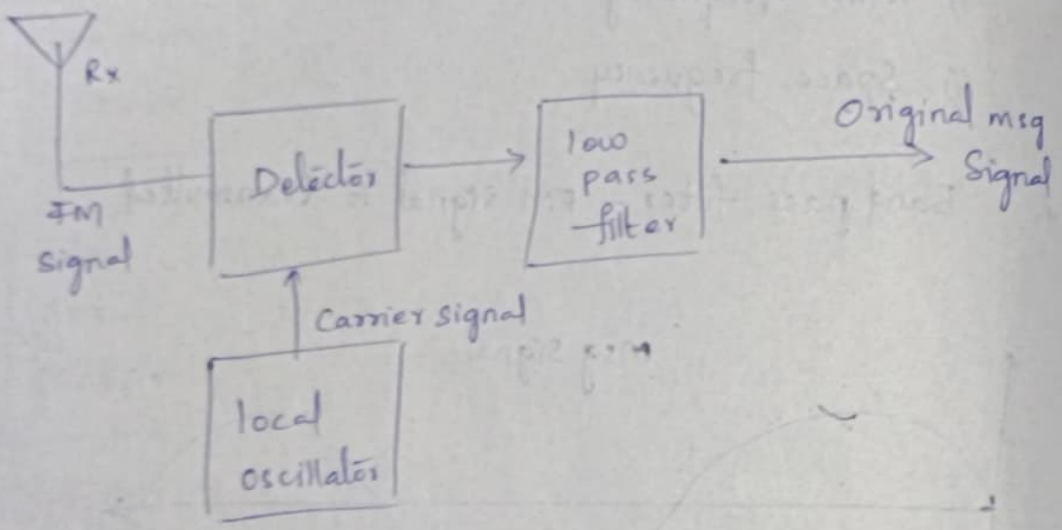
3. Modulator generates FM signals in to various frequencies namely
   i) Mark frequency
   ii) Space frequency

4. Band pass filter - FM signal is transmitted.



FM demodulation:

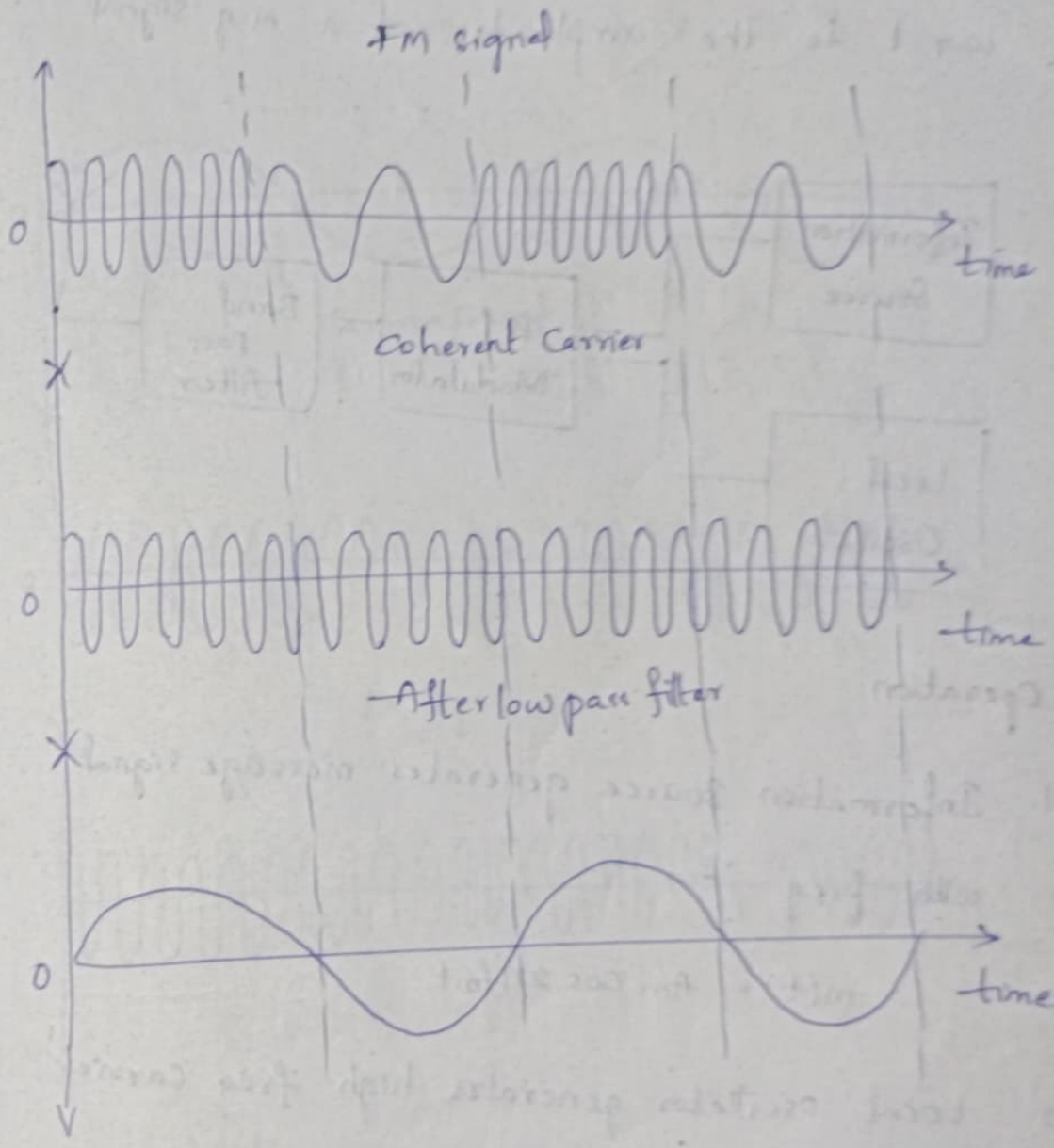
The process of removing carrier signal from FM signal is called FM demodulation.



Operation:

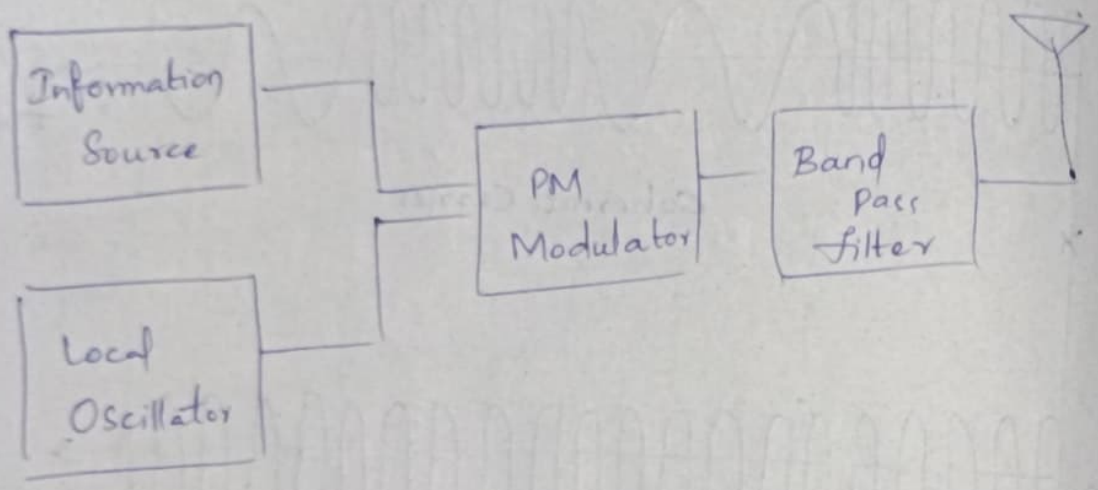
- Whenever FM signal is presented at the demodulator or detector it Compares with local carrier
- Local oscillator produces a coherent Carrier or synchronous Carrier with freq 'fc'
- The o/p of detector is a msg signal which is produced based upon Comparision

- After low pass filter it produces Original msg signal



3. Phase Modulation (PM):

The process of changing phase of a Carrier Signal w.r.t to the amplitude of a msg signal



Operation:

1. Information Source generates message signal with freq 'fm'

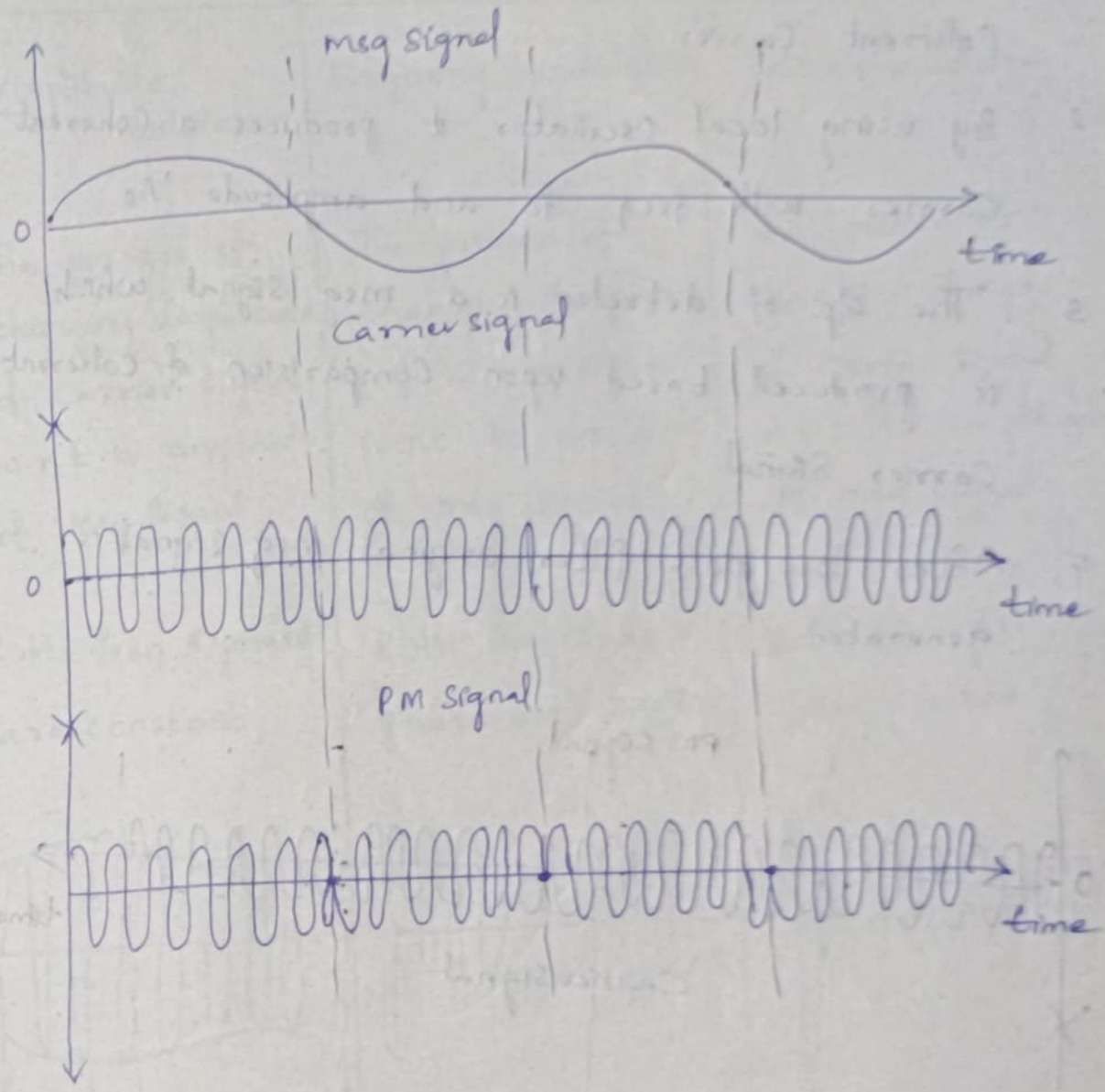
$$m(t) = Am \cos 2\pi fmt$$

2. Local oscillator generates high freq Carrier Signal with freq 'fc'

$$c(t) = Ac \cos 2\pi fct$$

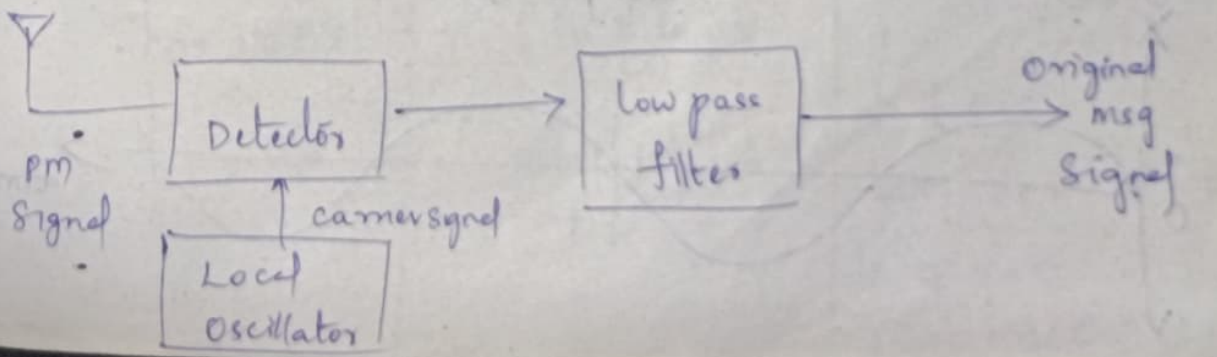
3. By using modulator the phase of Carrier Signal Varies w.r.t msg signal (Constant Amplitude freq)

4 By using band pass filter, PM signal is transmitted



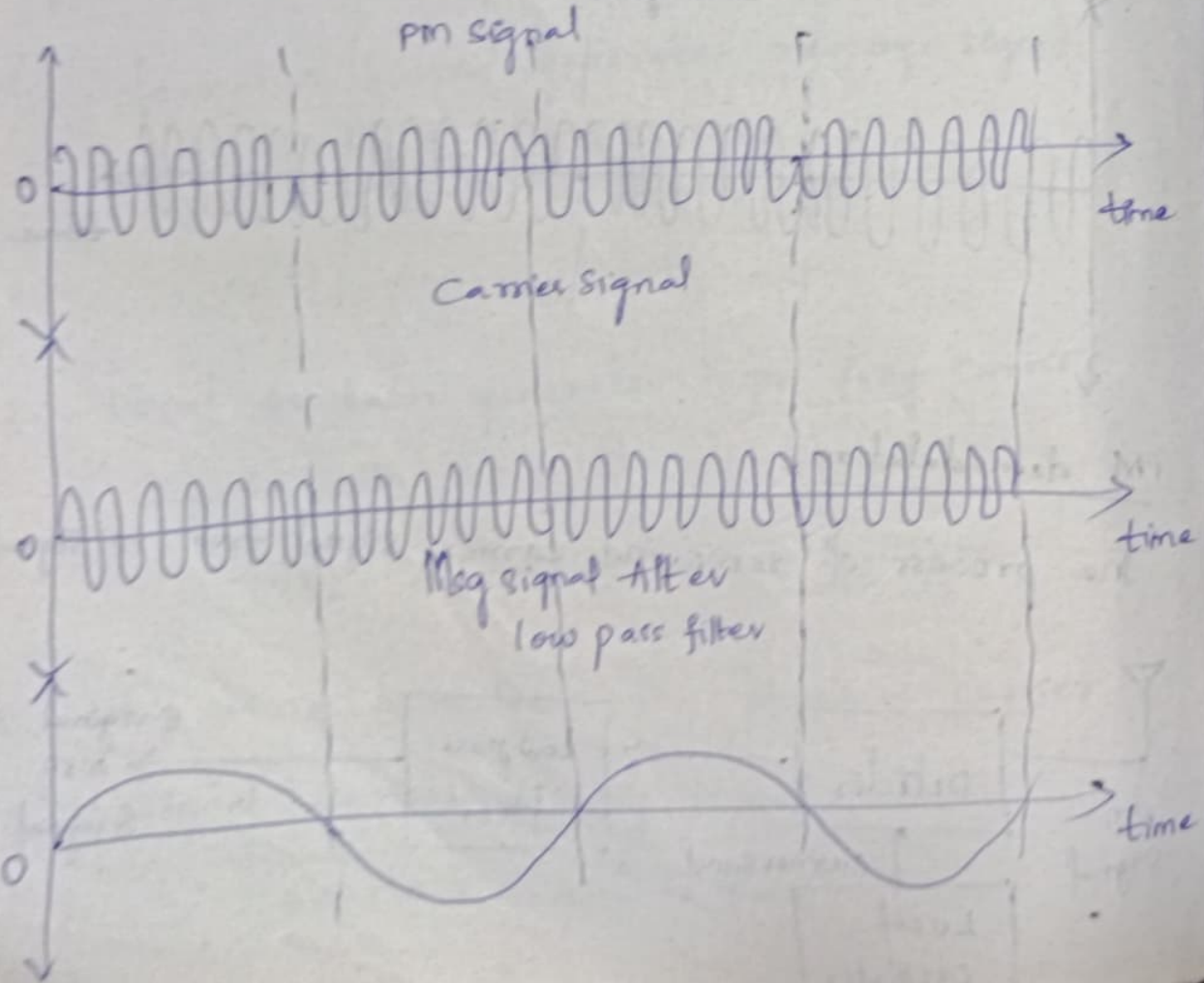
PM demodulation

The process of removing carrier signal from PM signal

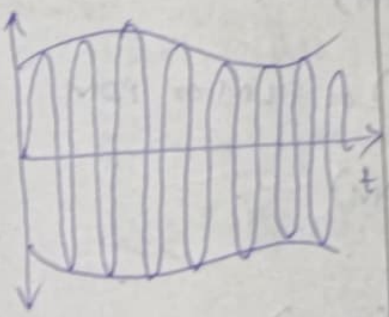
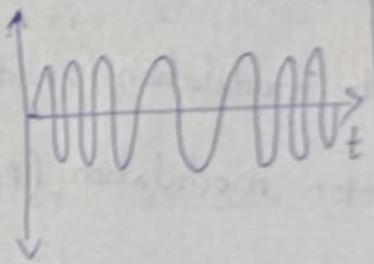
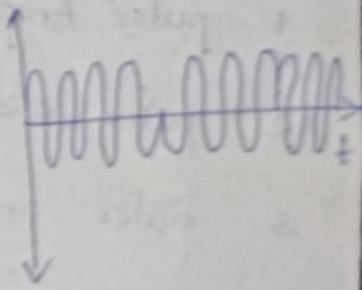


Operation:

1. Whenever PM signal is presented at the demodulation or detector it compares with Coherent Carrier
2. By using local oscillator it produces a Coherent Carrier with freq 'fc' and amplitude 'Ac'.
3. The o/p of detector is a msg signal which is produced based upon Comparision of Coherent Carrier Signal
4. After low pass filter original msg signal is generated.

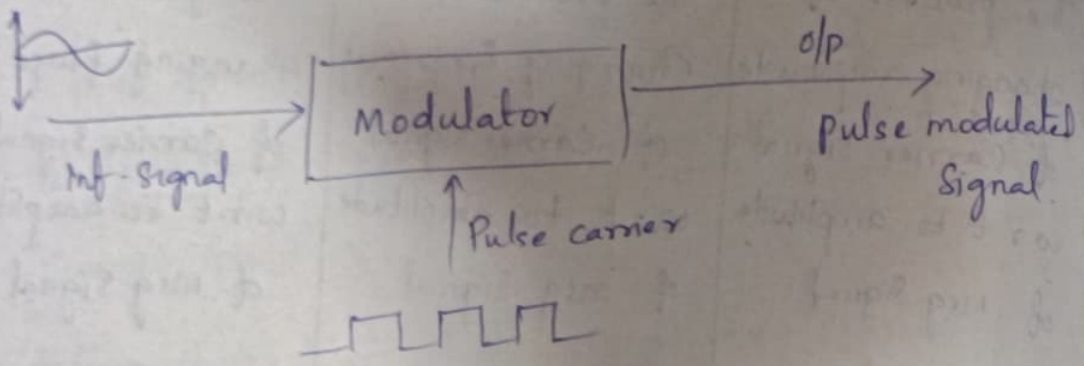


Comparision of Modulations:

AM	FM	PM
Amplitude modulation	Frequency modulation	phase modulation
The process of changing amplitude of Carrier signal w.r.t to amplitude of msg signal	The process of changing frequency of Carrier signal w.r.t to amplitude of msg signal	The process of changing phase of carries signal w.r.t to amplitude of msg signal.
Both freq & phase are constant	Both amplitude & phase are Constant	Both freq & amplitude are constant
		
$S(t) = A_c[1 + k_a m(t)] \cdot \cos 2\pi f_c t$	$S(t) = A_c \cos 2\pi (f_c \pm f_a)t$ mark / space + −	$S(t) = A_c \cdot \cos 2\pi (f_c + \theta)t$ $\Rightarrow$ if $\theta = 0$ $S(t) = A_c \cos 2\pi f_c t$ $\Rightarrow$ if $\theta = 90$ $S(t) = -A_c \sin$

Pulse Modulation:

The process of changing parameters of pulse Carrier w.r.t information signal is called pulse modulation

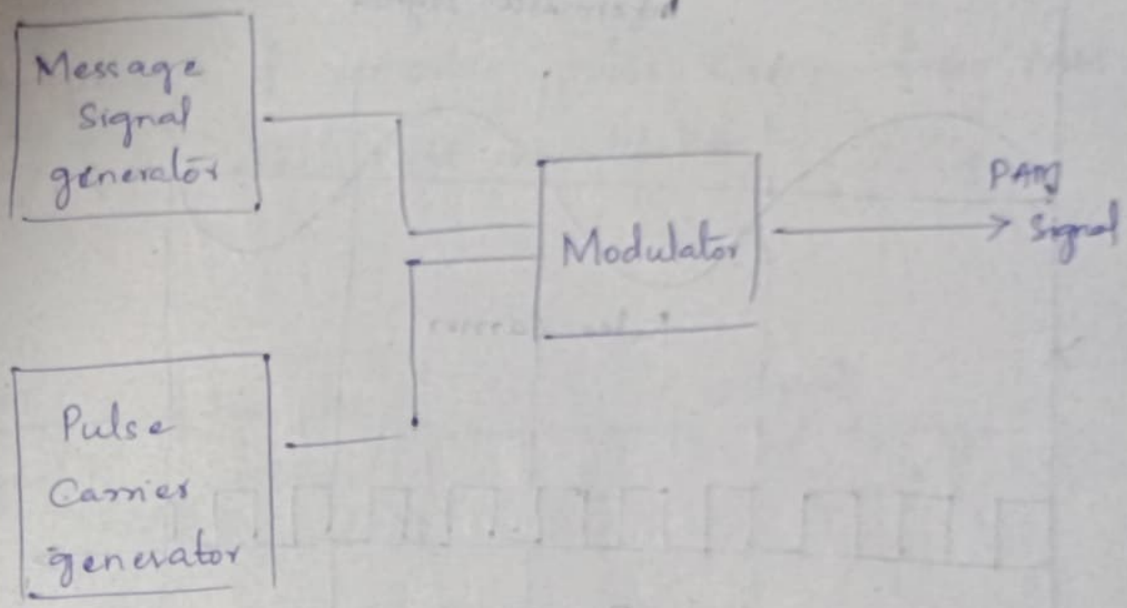


Based upon parameters of pulse carrier there are 3 types of pulse modulation:

1. pulse Amplitude modulation (PAM)
2. pulse width modulation (PWM) or PLM or PDM
3. pulse position modulation (PPM)

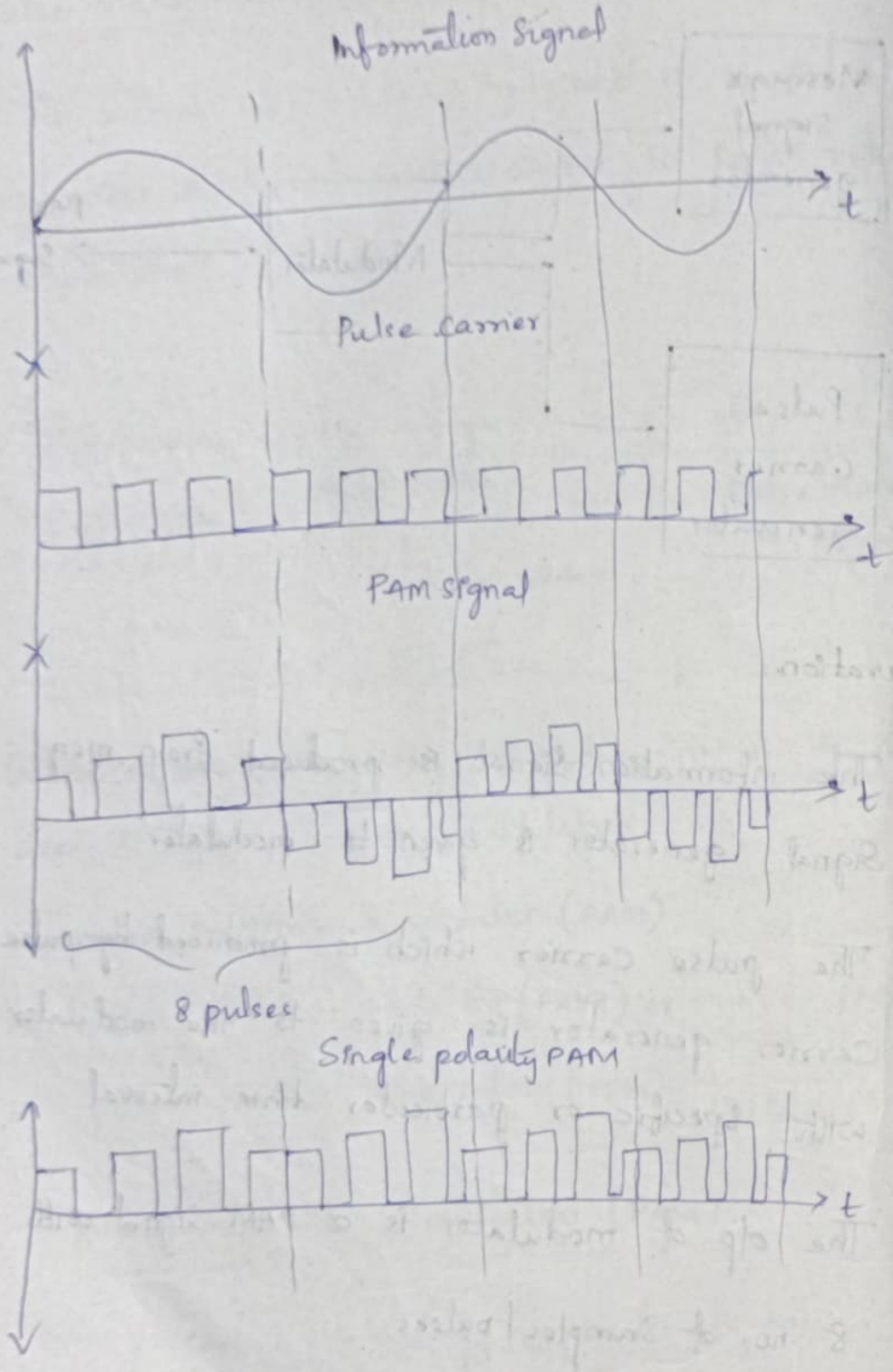
1. pulse Amplitude modulation (PAM)

The process of changing amplitude of pulse Carrier w.r.t information signal / msg signal is called as PAM



Operation:

1. The information signal is produced from msg signal generator is given to modulator
2. The pulse carrier which is produced by pulse carrier generator is given to the modulator with specific or particular time interval
3. The o/p of modulator is a PAM signal with & no. of samples / pulses.

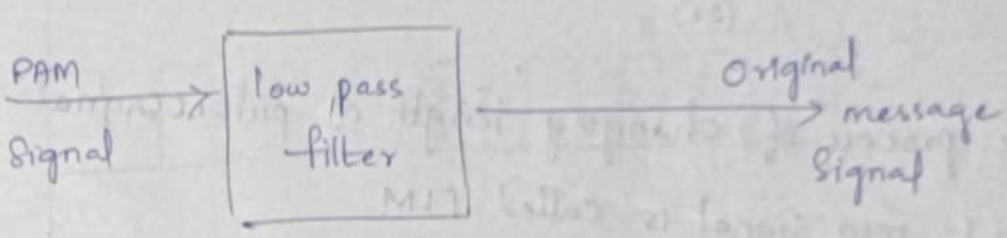


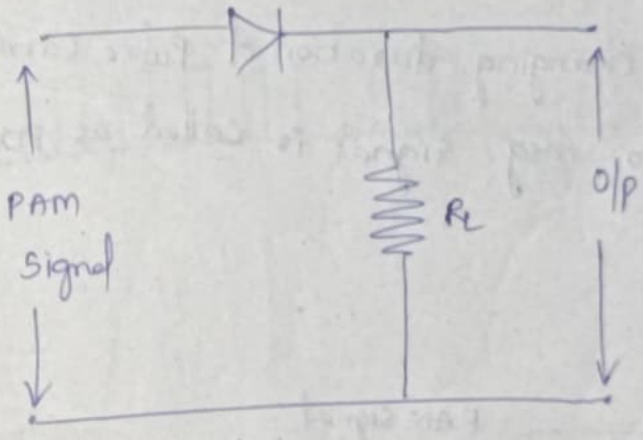
Reason:

- To increase no. of information signals
- To reduce wastage of pulses

PAM demodulation:

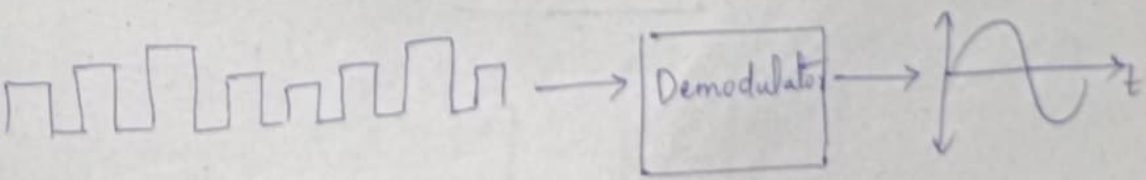
The process of removing pulse carrier from PAM signal is called PAM demodulation





1 Whenever PAM signal is presented across the low pass filter which removes high freq Carrier pulse by using diode

2 Across the register original signal is presented



2. pulse width modulation (PWM)

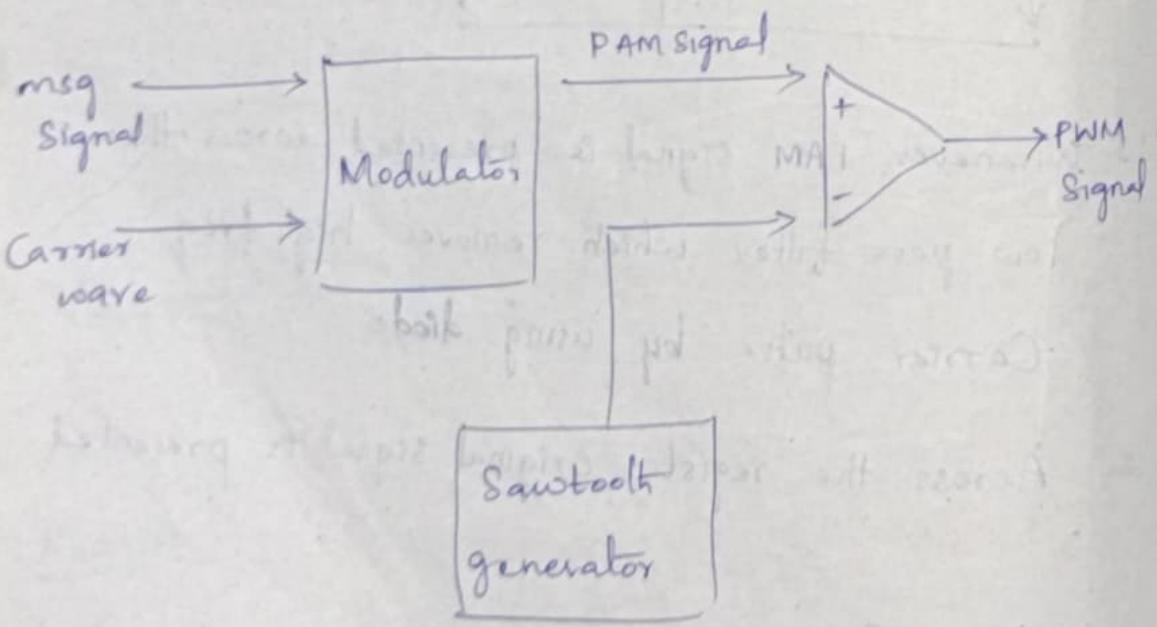
The process of changing width of pulse Carrier Signal w.r.t information signal / msg signal is Called PWM

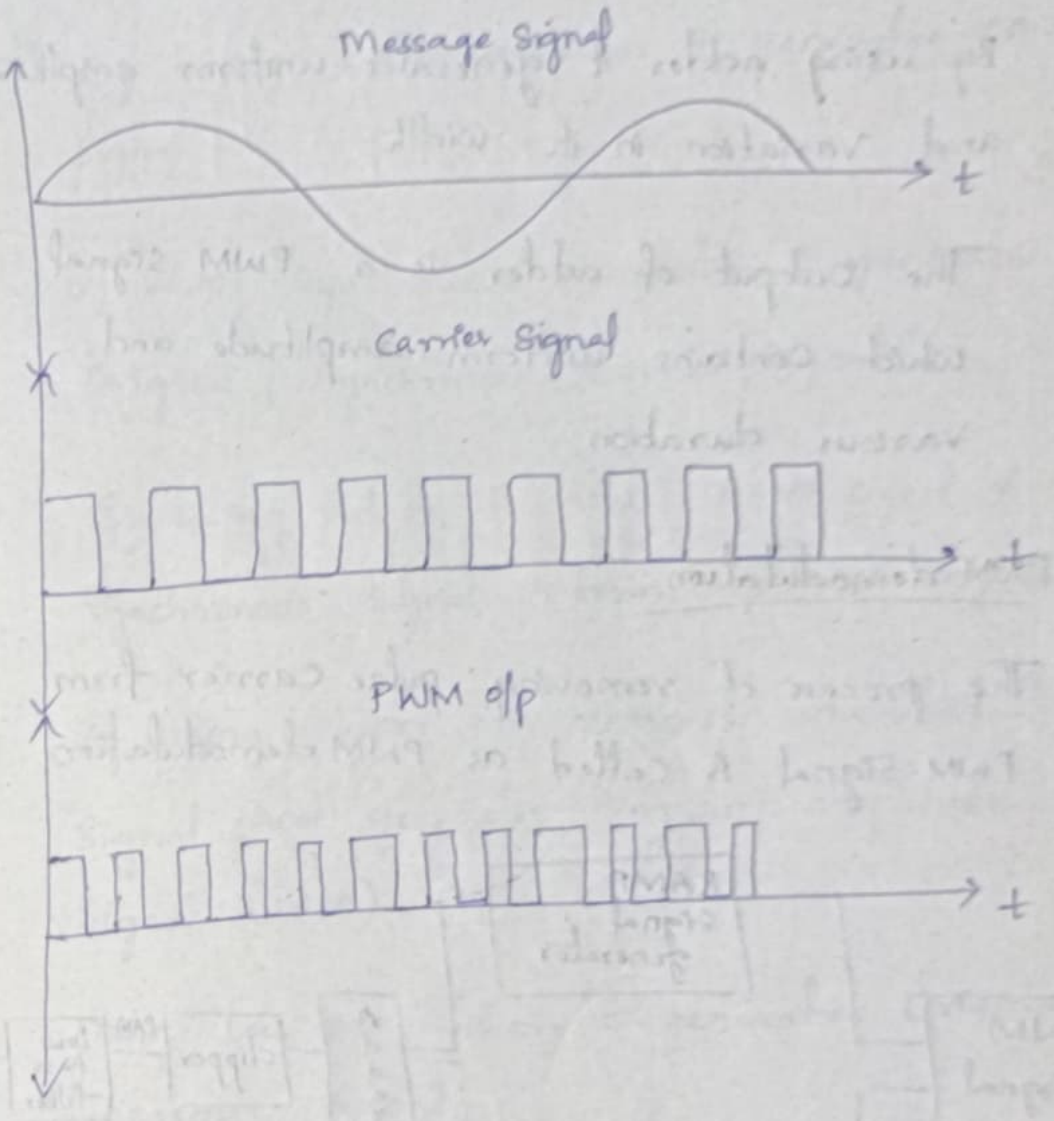
(or)

The process of changing length of pulse signal w.r.t msg signal is called PLM

(or)

The process of changing duration of Pulse Carrier Signal w.r.t to msg signal is called as PDM

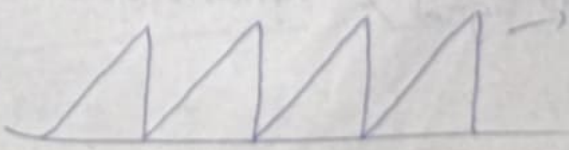




Operation:

1. Msg signal & Carrier (Signal) pulse is given to the modulator at a pre-defined instance time due to this it produces PAM signal

2. By using sawtooth generator it produces uniform amplitude & uniform width signal

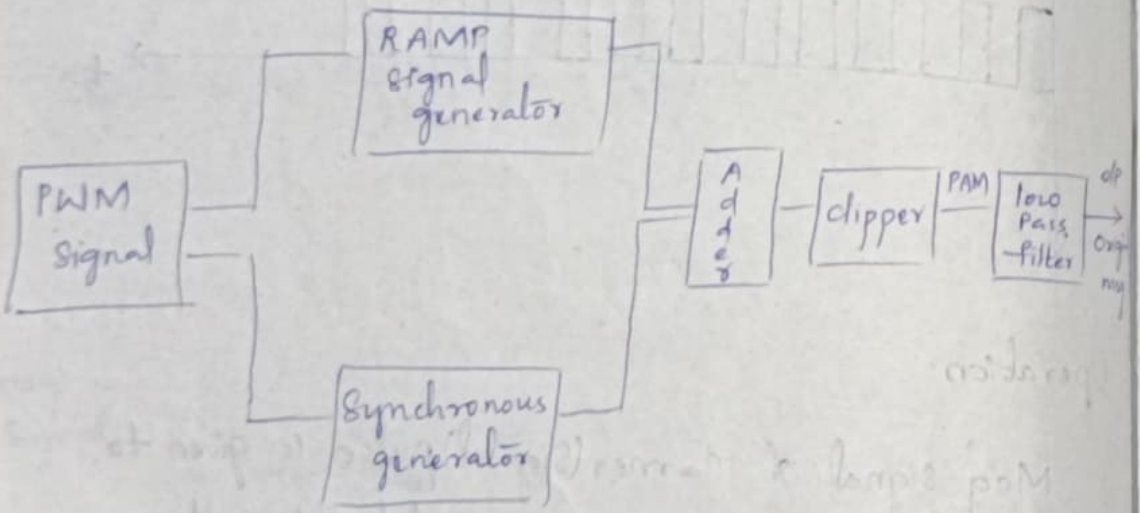


3. By using adder it generates uniform amplitude and variation in its width

4. The output of adder is a PWM signal which contains uniform amplitude and various duration.

PWM demodulation:

The process of removing pulse carrier from PWM signal is called as PWM demodulation



Working:

1. Whenever PWM signal presented at demodulator it generates two different wave forms based upon its width namely:
   RAMP signal & Synchronous signal

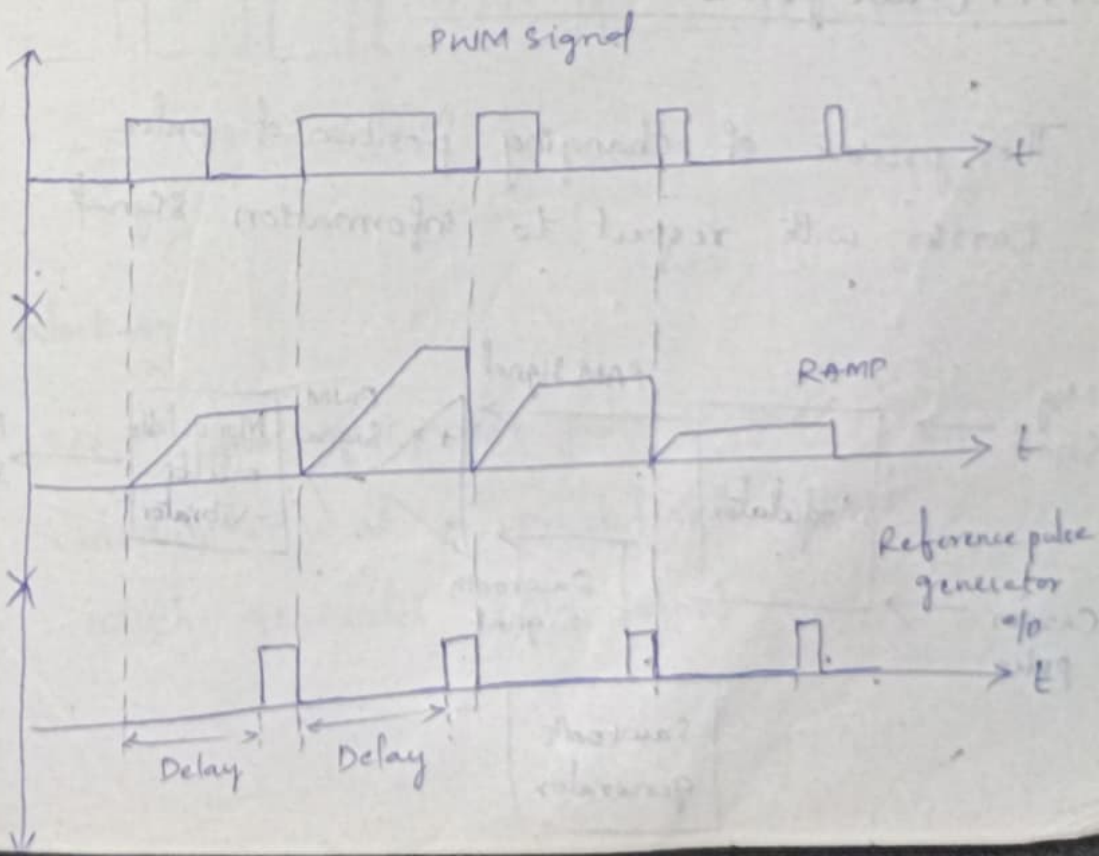
2. By using RAMP generator it generates RAMP Signal

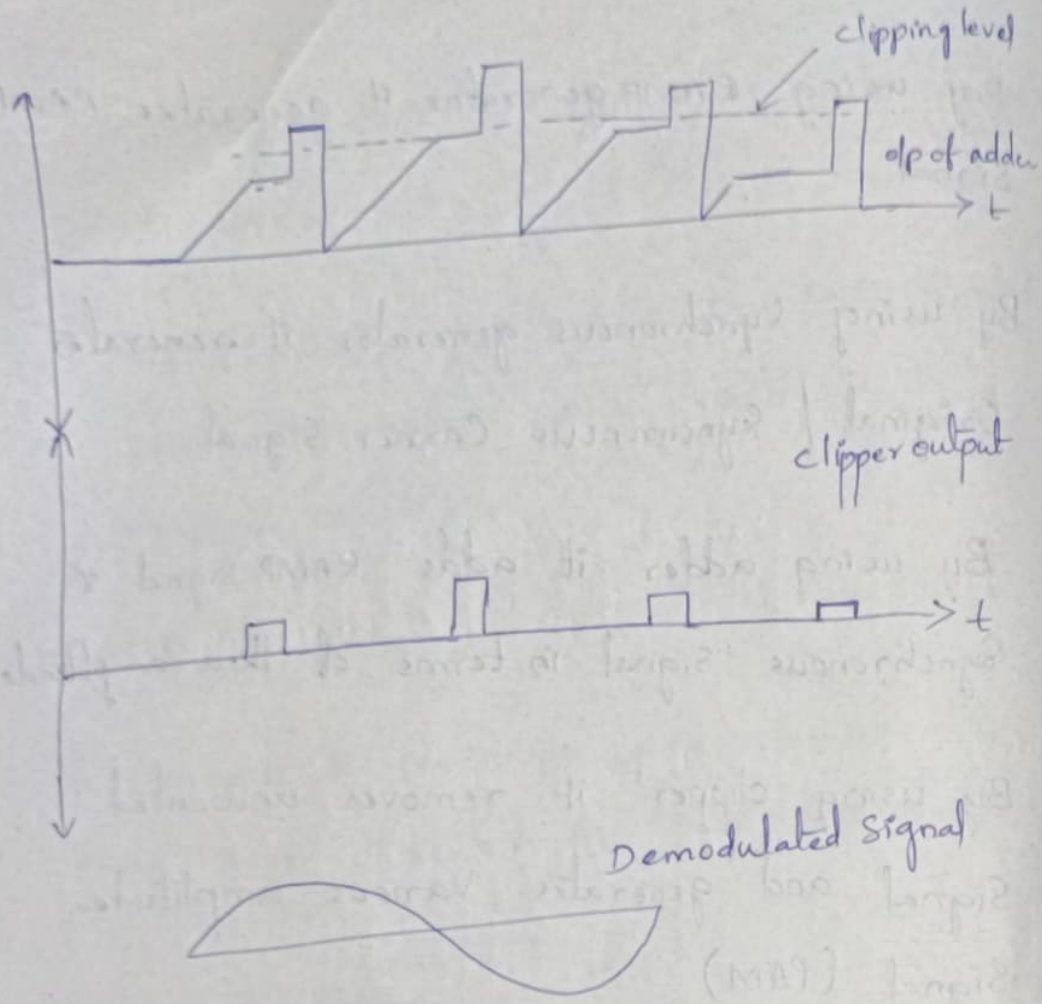
3. By using Synchronous generator it generates Original / Synchronous Carrier Signal

4. By using adder it adds RAMP Signal & Synchronous signal in terms of their amplitude

5. By using clipper, it removes unwanted Signal and generates Various amplitude Signal (PAM)

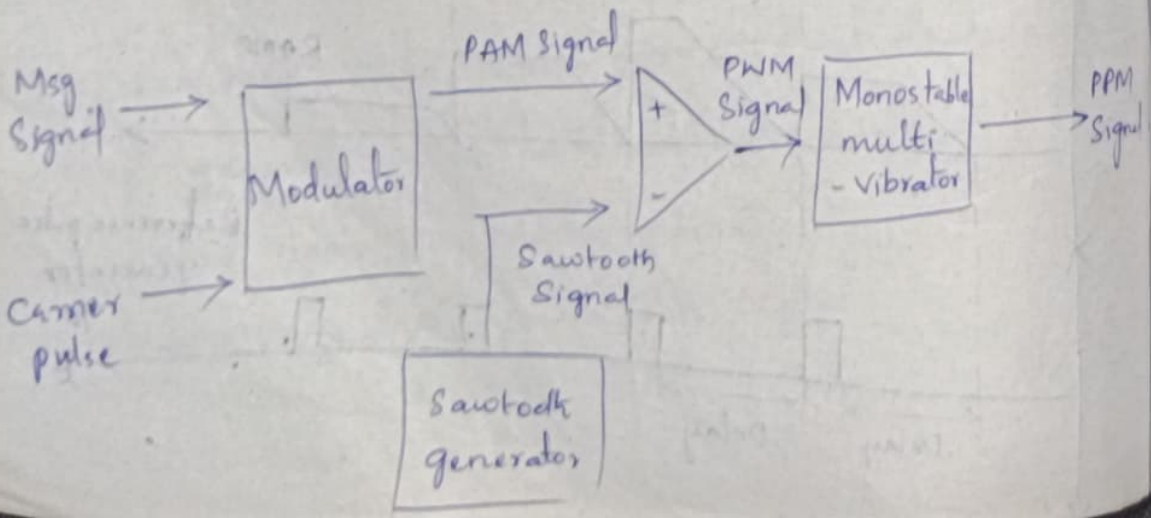
6. Using Low pass filter it generates Original message signal

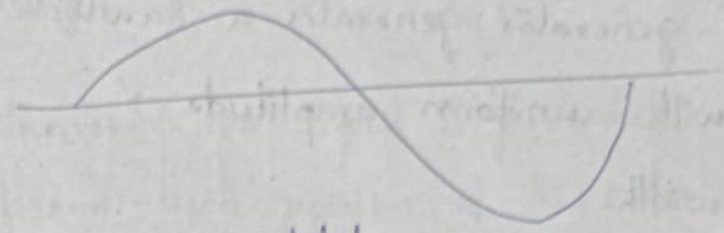




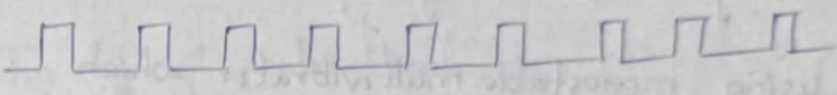
3. PPM (Pulse position modulation):

The process of changing position of pulse Carrier with respect to information signal

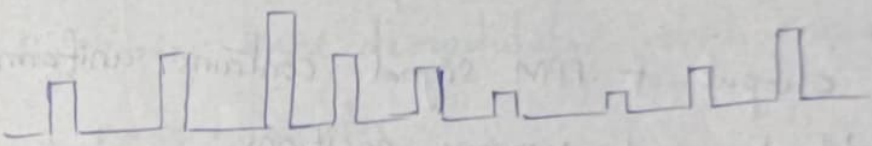




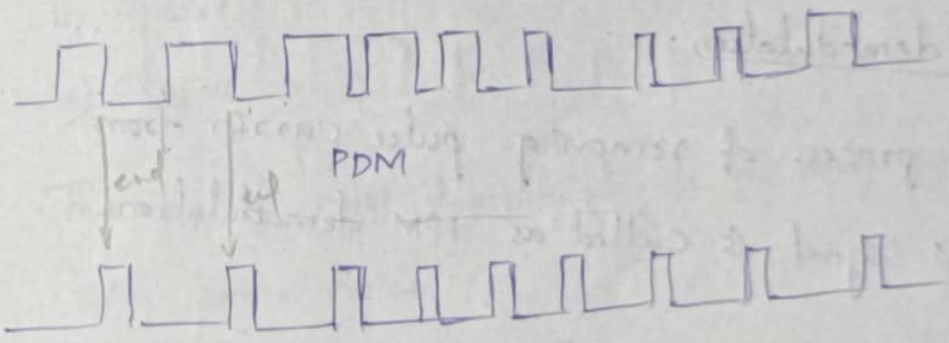
Modulating wave



Carrier



PAM



PDM

PPM

Working:

1. Msg signal & carrier pulse is given to the modulator at a predefined instant. which generates PAM signal

2. Sawtooth generator generates a sawtooth signal with uniform amplitude & uniform width

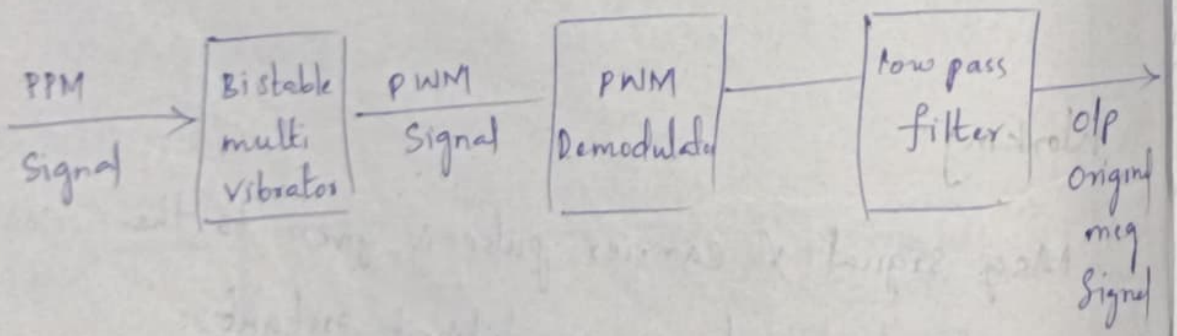
3. By using adder it generates PWM signal

4. By using monostable multivibrator which converts PWM signal in to PPM signal

5. The output of PPM signal contains uniform amplitude and various positions

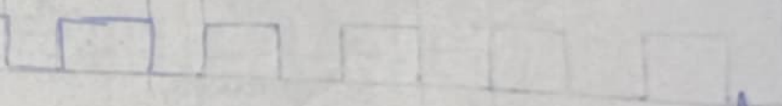
PPM demodulation:

The process of removing pulse carrier from PPM signal is called as PPM demodulation

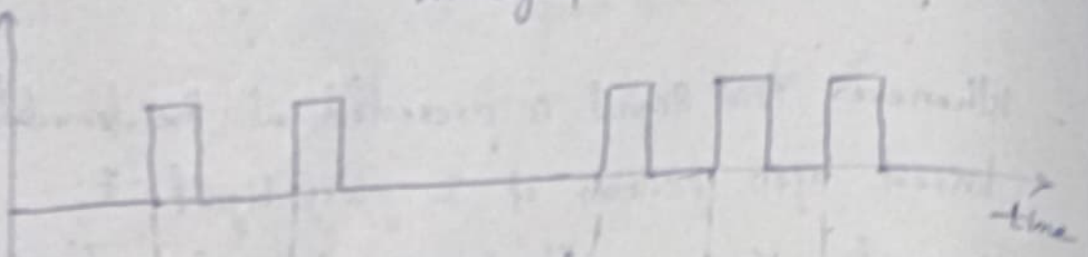


Working:

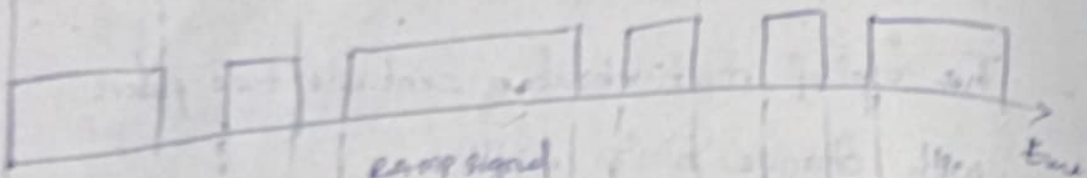
- Whenever PPM signal is presented at the demodulator based upon 'position of the pulse' signal it generates Varies width by the help of multivibrator
- The o/p of multi-vibrator contains two pulses with change in its width
- By using PWM demodulator which contains
  i) RAMP generator
  ii) Sychronous generator
  iii) Adder
  iv) Clipper
- The o/p of PWM demodulator is a msg signal with some noise
- By using low pass filter noise is removed and it generates Original msg signal.



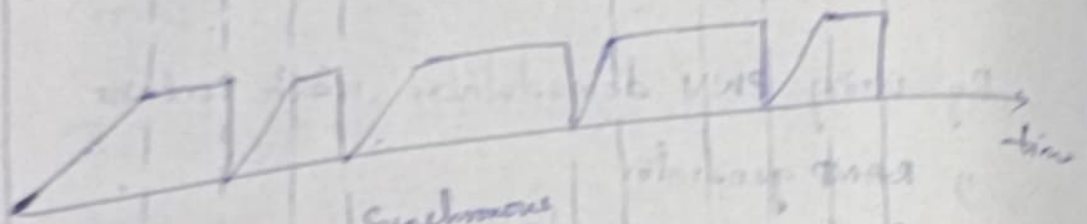
PPM signal



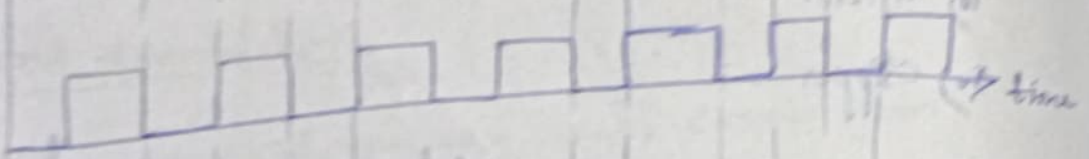
PWM signal



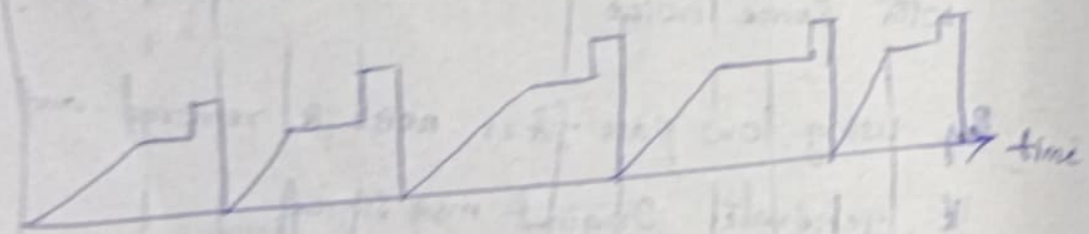
Ramp signal



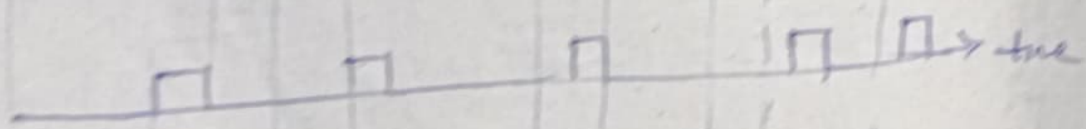
Synchronous

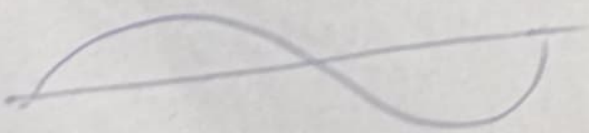


Adder



Clipper



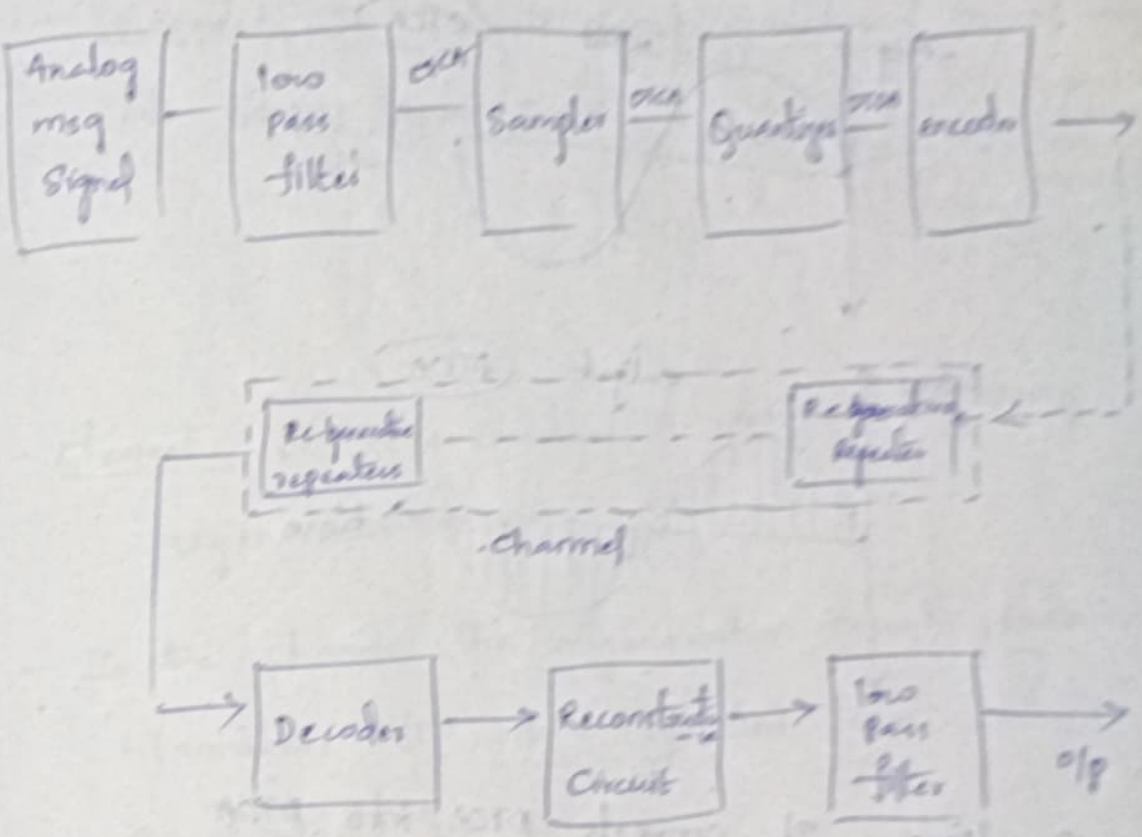


Msg signal

PCM (Pulse code Modulation)

The process of converting analog msg signal into codes (or) Binary bits

Transmitter



Receiver

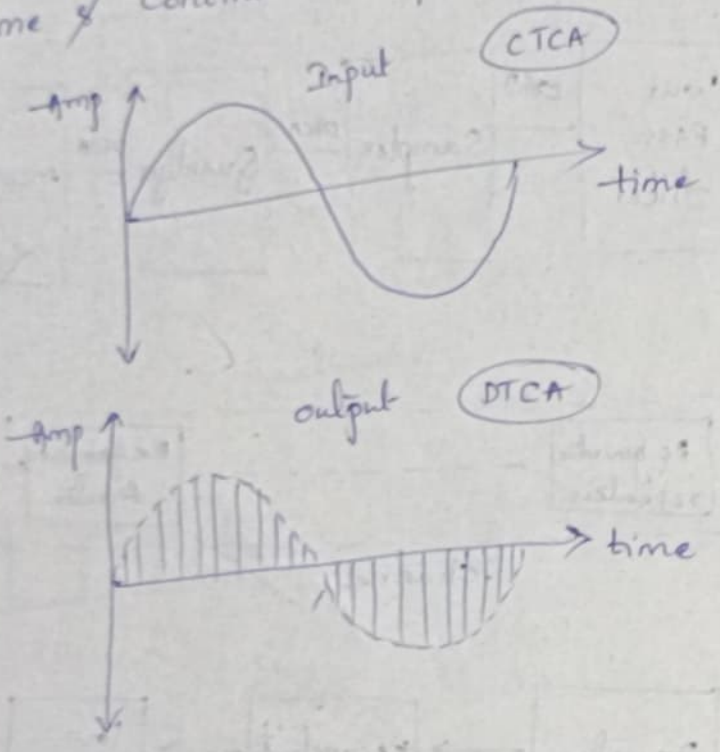
Working:

- The i/p of PCM is a analog msg signal with frequency 'fm'

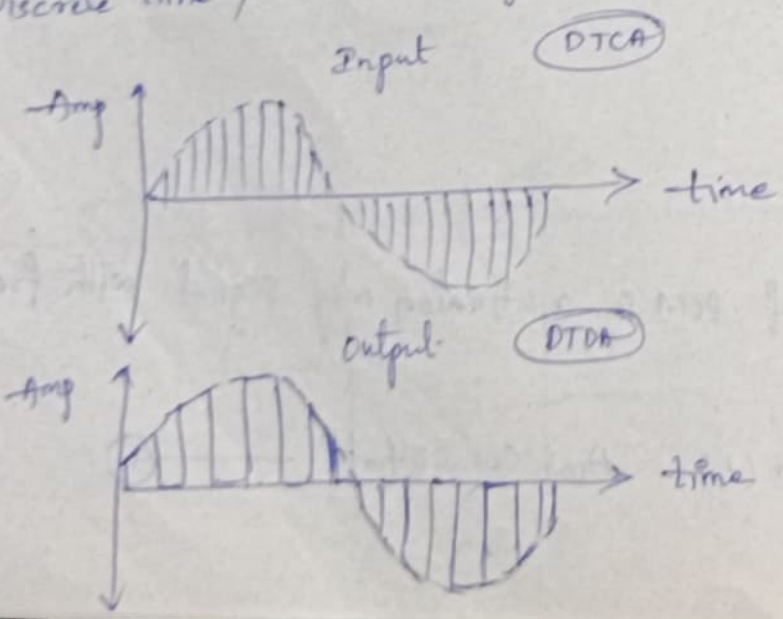
$$m(t) = A_m \cdot \cos 2\pi f_m t \quad \text{——— (1)}$$

- By using low pass filter noise is removed with a predefined frequency 'fm'

- Sampler: It converts continuous time and continuous amplitude signal into discrete time & continuous amplitude signal (DTCA)



- Quantizer: It converts DTCA into DTDA (Discrete time & discrete amplitude) signal



- The o/p of quantizer i.e., DTDN signal is always round-off amplitude values ex: 1.5 ≈ 1V
  1.56 ≈ 2V
  2.6V ≈ 3V
  2.4V ≈ 2V
  4.7V ≈ 5V

- Encoder: It converts input quantized signal into binary signal / codes.

ex		B421
	2V	0010
	3V	0011
	1V	0001

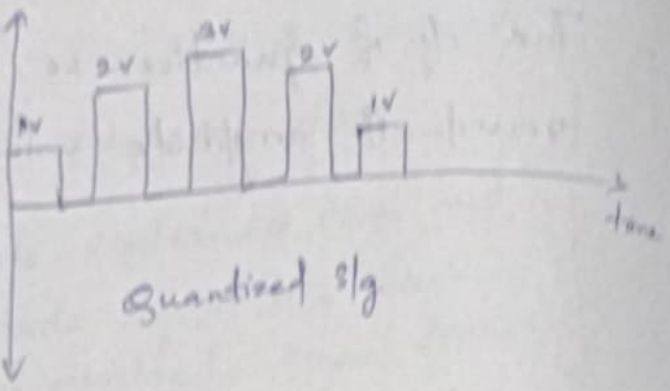
- Channel: In PCM channel is designed by using regenerative circuits

- In the channel the regenerative circuit produces information bits with a specified length - "8bits" or "1 byte"

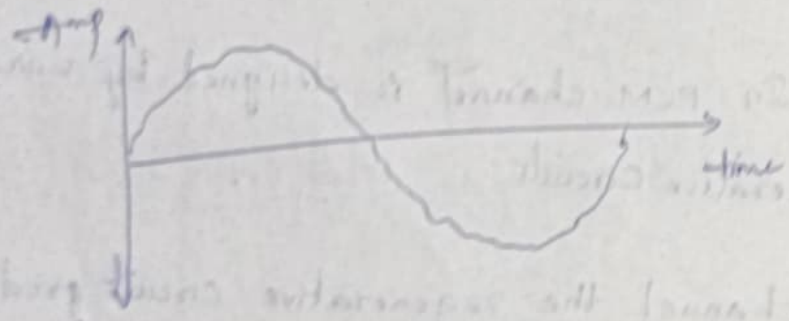
  Drawback: Missing of data / Bits
  Collision of bits
  Error

- Decoder: The device which converts ip binary bits into Quantized levels.

0001 = 1V
0010 = 2V
0011 = 3V
0100 = 4V



- Reconstructive Circuit: The circuit which converts Quantized signal into continuous in time & continuous in amplitude signal



- low pass filter: The device which removes noise or distortion presented in the signal and produce original msg signal

Digital Modulation:

The process of changing parameters of carrier signal with respect to digital / Binary information bits

Types:

Based upon carrier parameters there are 3 types of digital modulation namely

1. ASK (Amplitude shift keying) / ON-OFF Key (OOK)
2. FSK (Frequency shift keying)
3. PSK (Phase shift keying)

1. ASK (Amplitude shift keying) – Telephony

The process of changing amplitude of carrier signal w.r.t to digital / Binary information bits

In General, In ASK the carrier signal varies in its amplitude based upon input bits i.e,

logic 1 ⟶ Amplitude presented "ON"

logic 0 ⟶ Amplitude absent "OFF"

Voltage levels

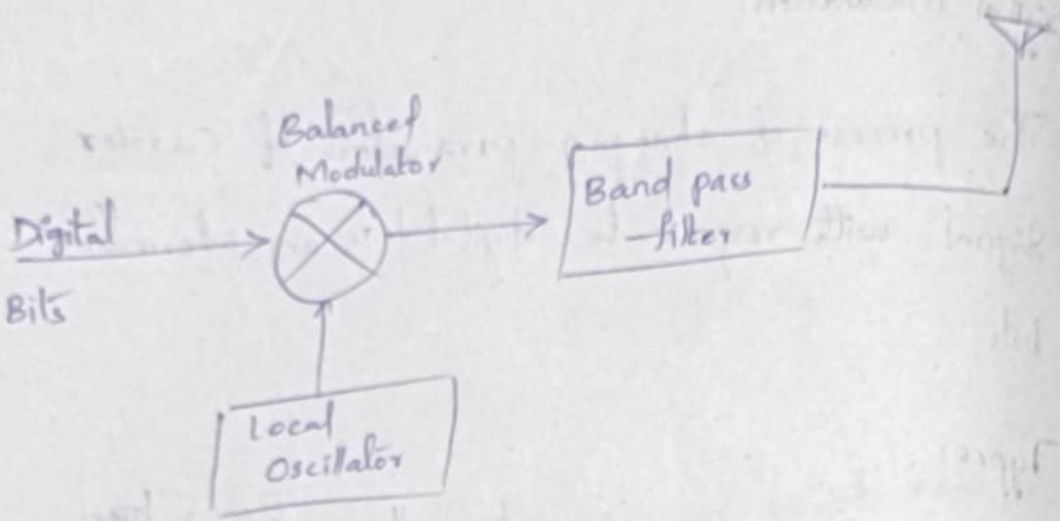
logic 1 ⟶ 2.5 V — 5V

logic 0 ⟶ 0V — 1.5 V

(or)

2.5 V

} In Hw check value

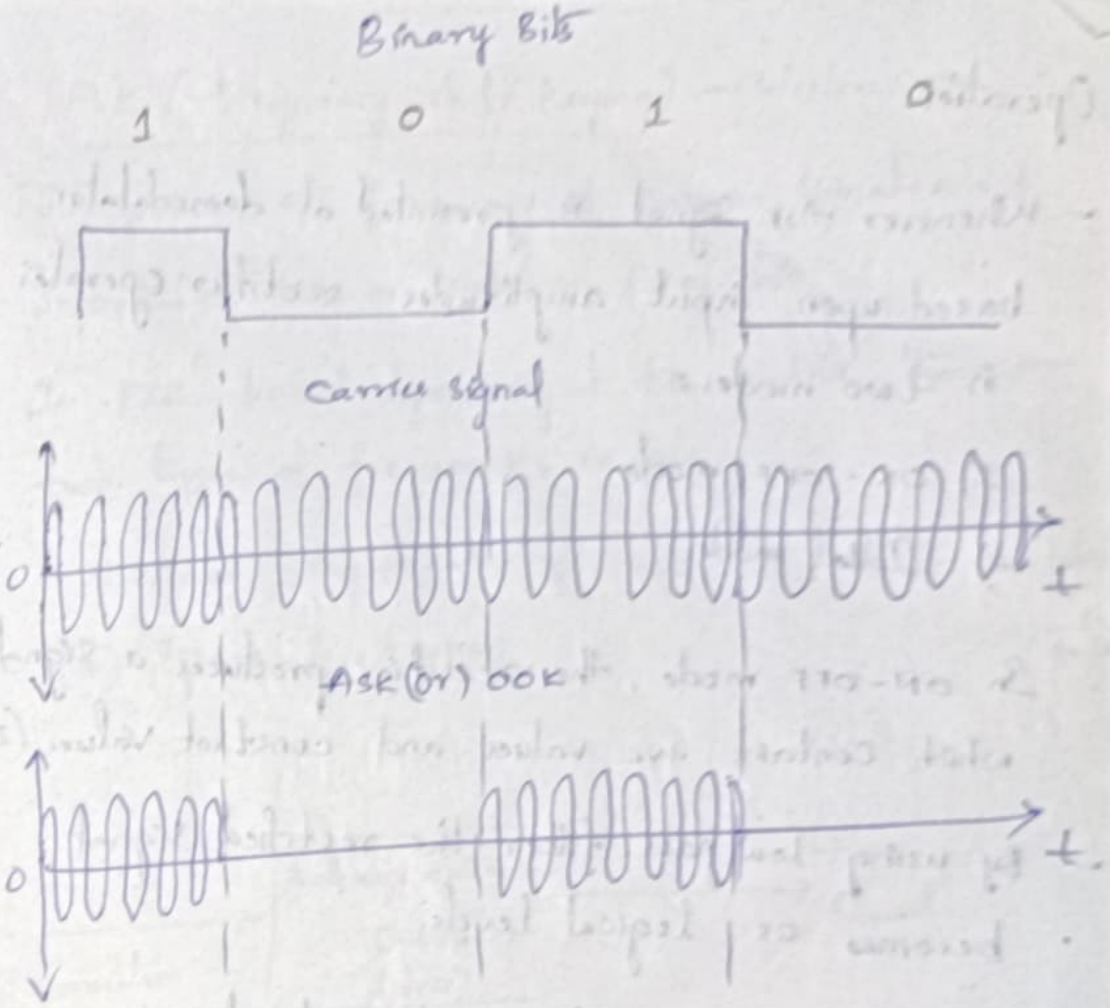


Operation:

- Msg signal i.e., Digital bits are given to the balanced modulator at a specify time interval
- A high frequency carrier signal is generated from local oscillator with a frequency 'fc'

$$c(t) = A_c \cos 2\pi f_c t$$

- Based upon information bits balanced modulator generates ASK signal
- By using Bandpass filter ASK signal is transmitted

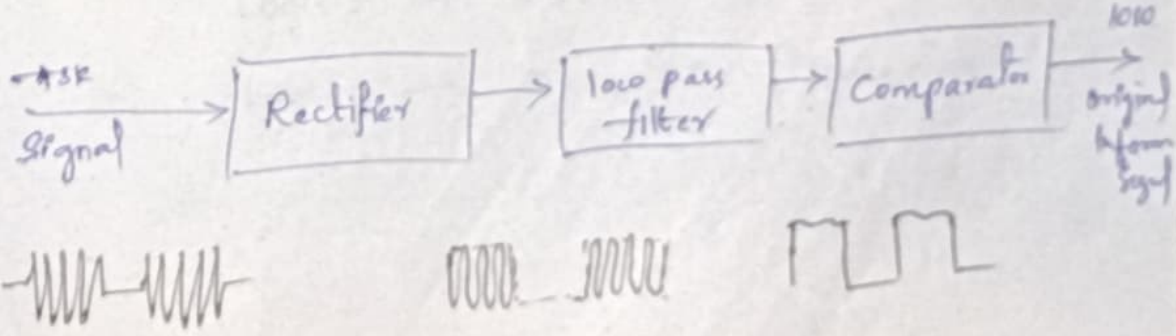


ASK demodulation

The process of generating original information bit from ASK modulated signal

(or)

The process of removing carrier signal from ASK Modulated signal



Operation:

- Whenever ASK signal is presented at demodulator based upon input amplitudes rectifier operates in two modes:

1) ON-OFF mode
2) Idlal mode

- In ON-OFF mode, the rectifier produces a signal which contains +ve values and constant values (zero)
- By using low pass filter the rectified signal becomes as logical levels.
- By using comparator i/p logic levels are converted into binary bits / information bits

ex: 3.5 V → logic 1

2.2 V → logic 0

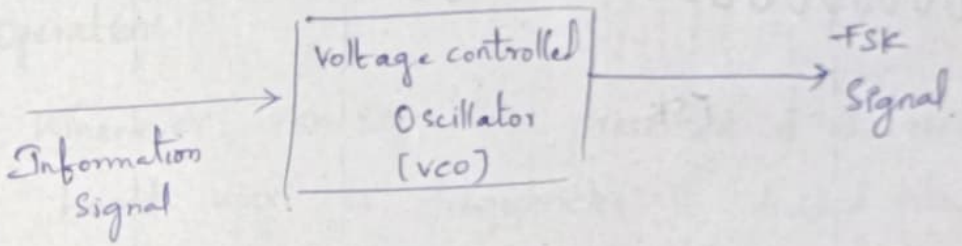
1.5 V → logic 0

4.5 V → logic 1

2. FSK (Frequency shift keying) → Telephone Comm

- The process of frequency of carrier signal w.r.t Information bits or Digital or Binary bits
- In FSK, based upon input binary bits there are two types of frequencies namely:
  1) Mark frequency
  2) Space frequency

vco → one time input or oscillator



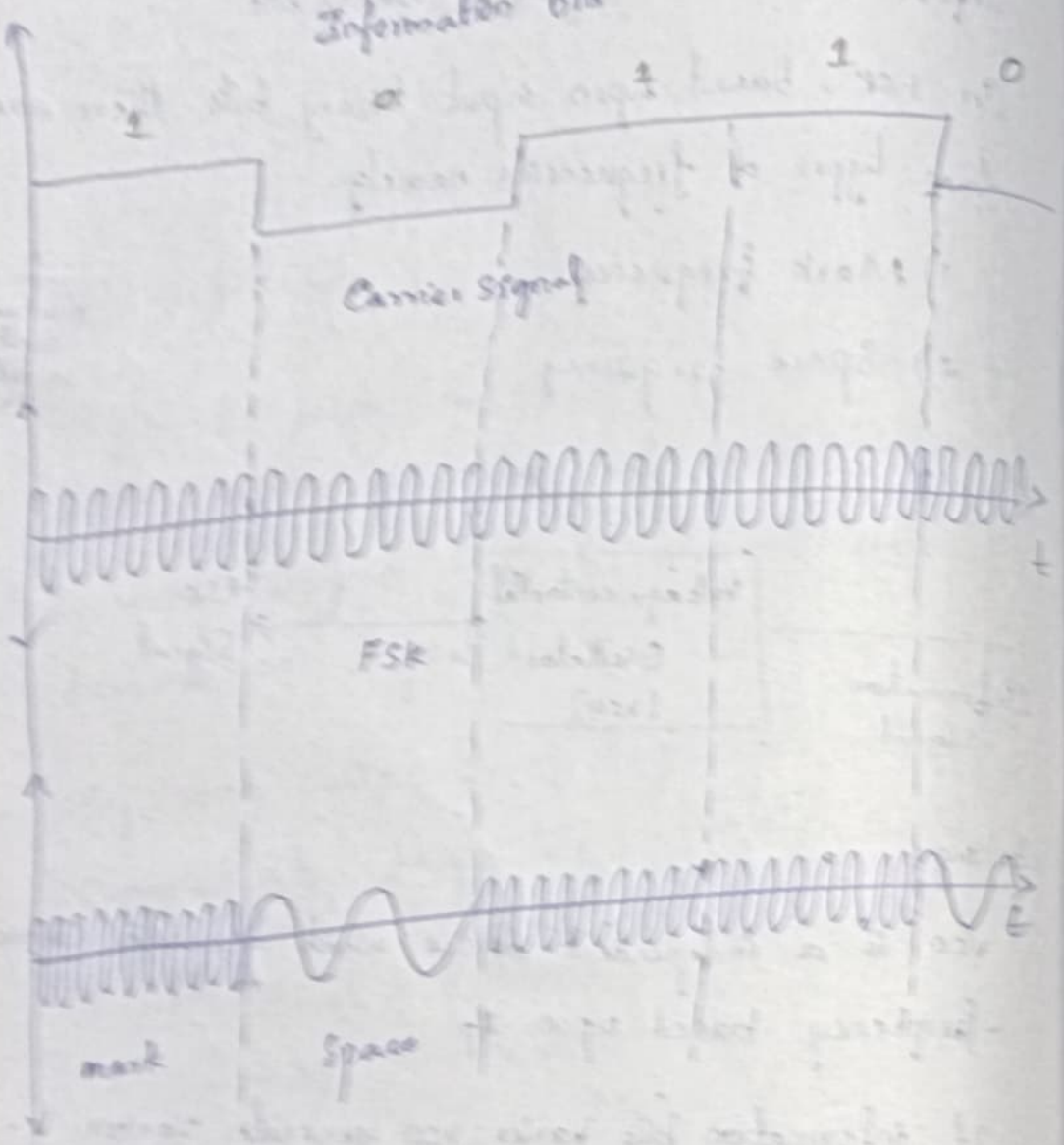
Working:

- VCO is a independent device which generates Carrier frequency based upon I/p
- If information bits varies VCO generates various signal based upon Logic-High & Logic low voltage levels i.e.,

  Logic 1 → 3.5V - 5V (mark freq)

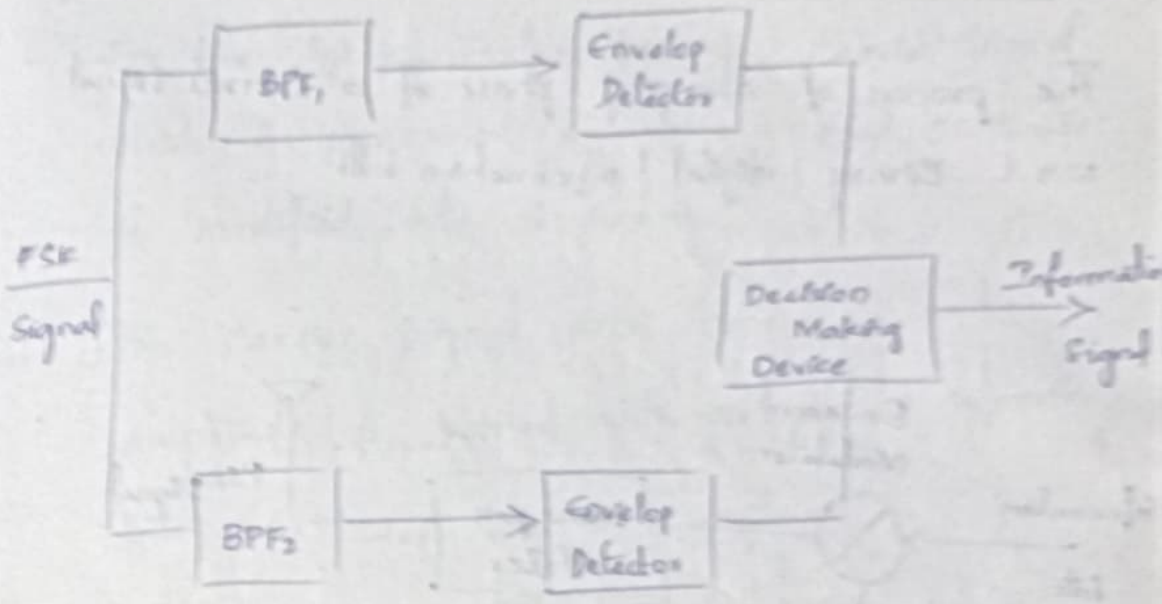
  Logic 0 → 0V - 2.5V (space freq)

- The o/p of vco is FSK signal having two types of frequencies with same phase



FSK demodulation / coherent demodulation

The process of recovering carrier signal from FSK modulated signal



Operation:

- Whenever FSK signal is presented at the demodulator based upon its frequencies it divided into two parts
- By using Band pass filters FSK is divided into 2 parts namely: Mark & Space frequencies

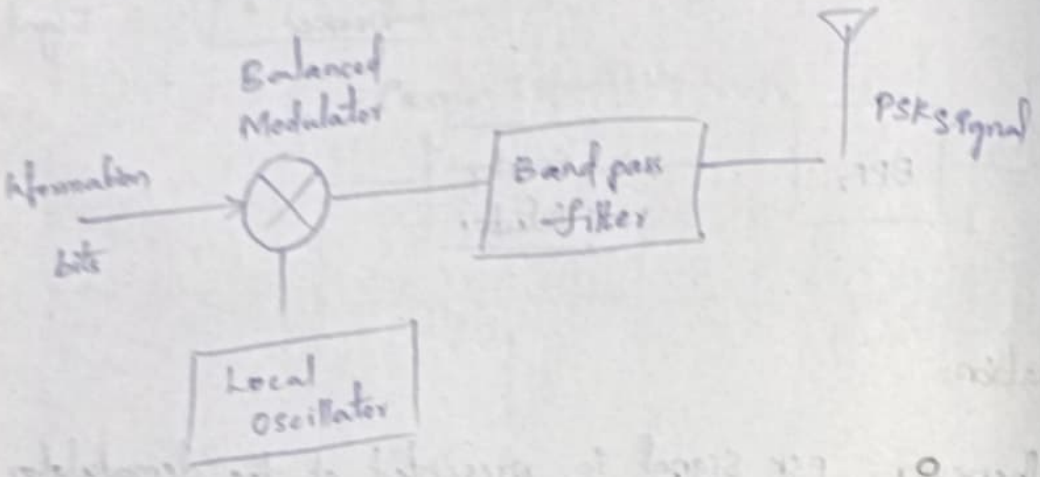
  BPF_1 - Allows only mark freq

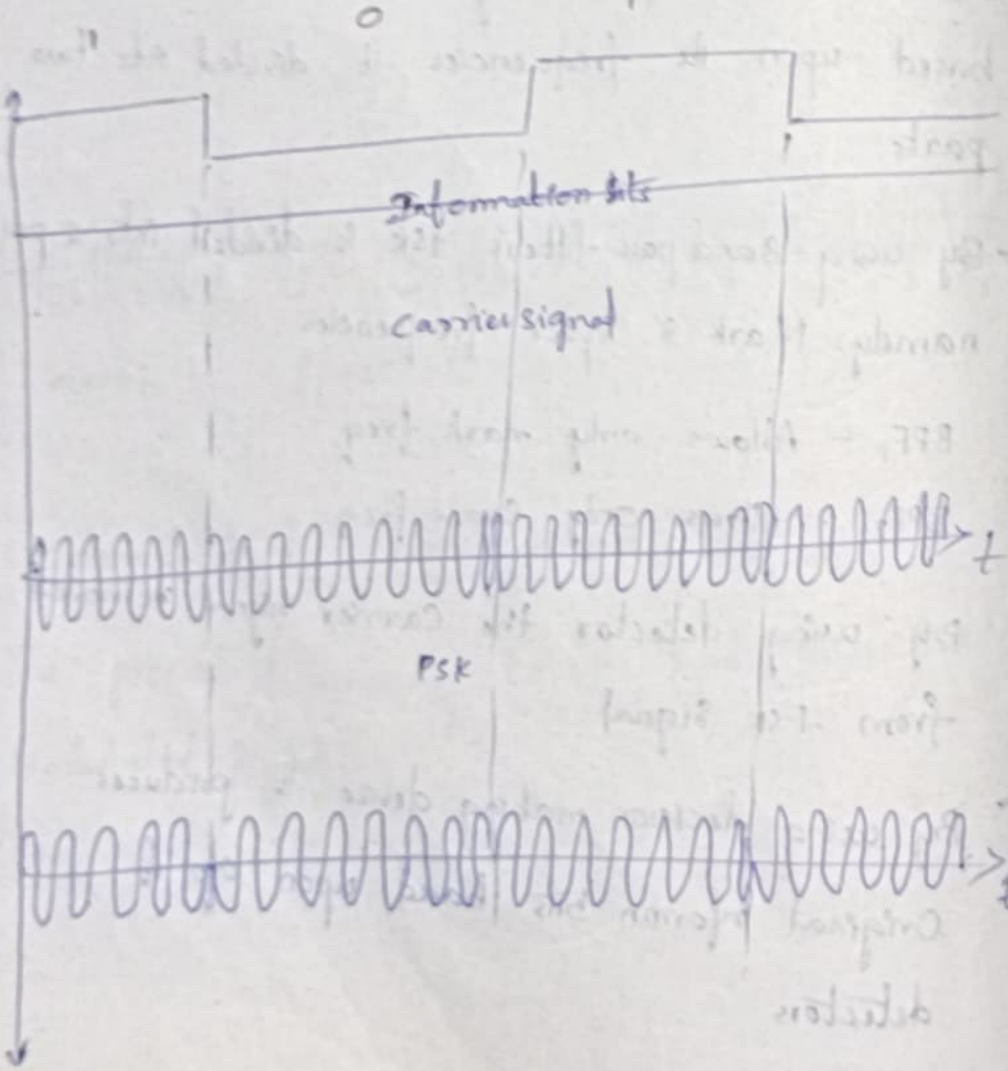
  BPF_2 - Allows only Space freq
- By using detector the Carrier signal removed from FSK signal
- By using decision making device it produces Original information bits based upon o/p of detectors

Ledi

3. PSK modulation:

The process of changing phase of a carrier signal w.r.t Binary / digital / information bits



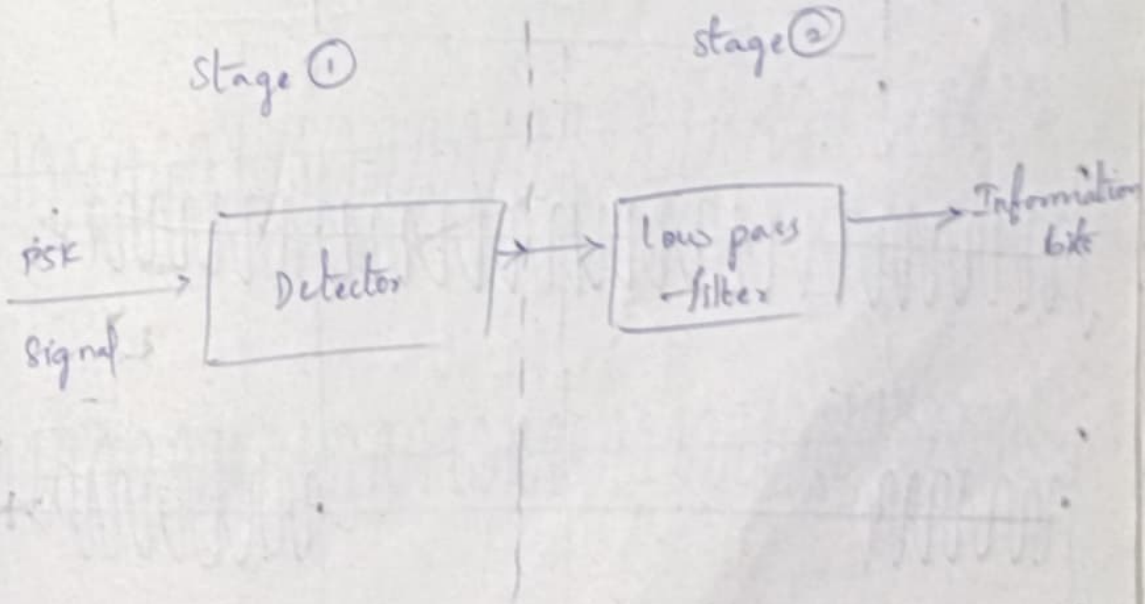


Operation:

- For the i/p information bits, the carrier signal which is generated by using local oscillator is modified into 2 phases.
- The carrier signal with same freq and amplitude is varied with respect to inform bits i.e., for logic 1 — Inphase
  logic 0 — Outphase
- By using Bandpass filter, PSK signal is transmitted

PSK demodulation:

The process of removing carries signal from PSK modulated signal



Operation:

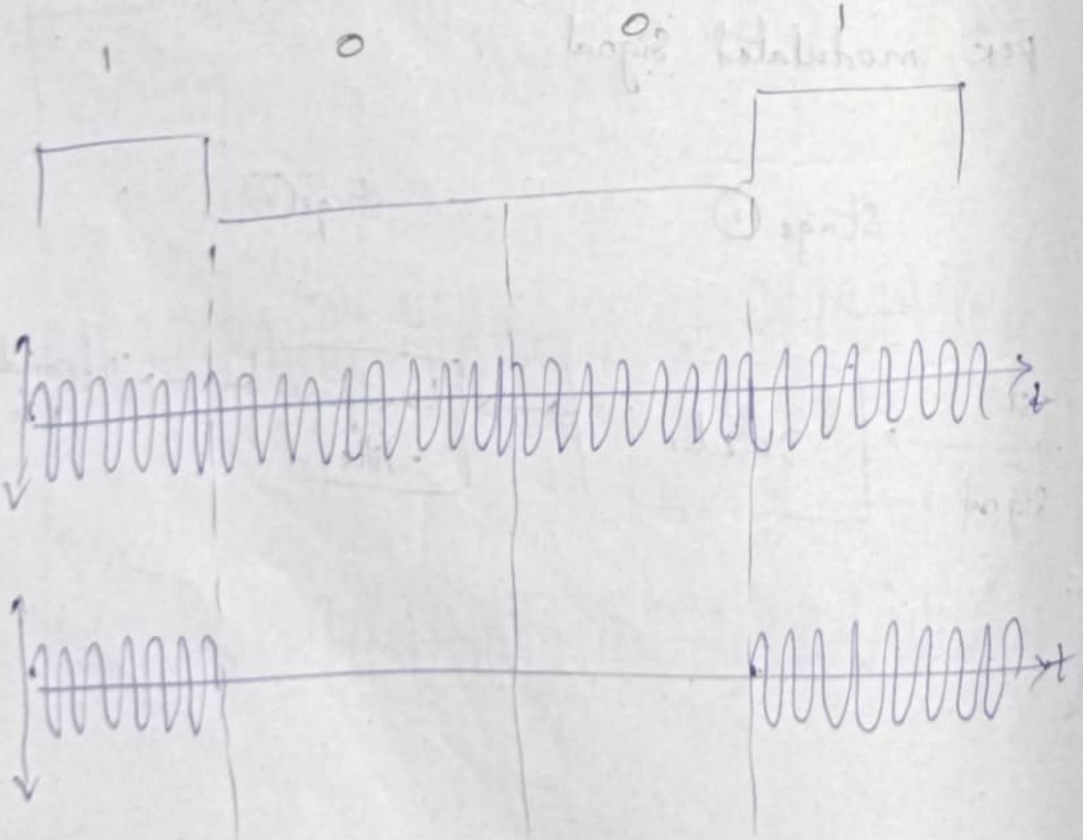
- Whenever PSK signal is presented at the demodulator it is divided into 2 stages namely

  Stage 1 & Stage 2.

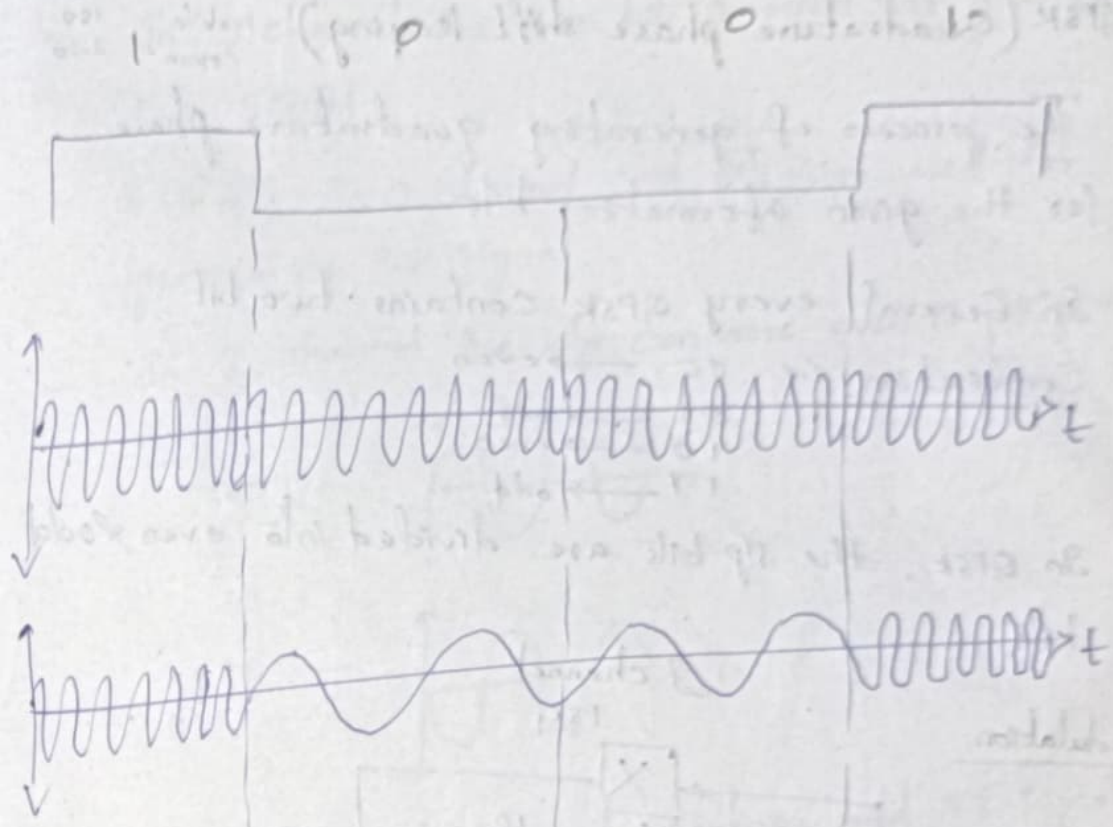
- Stage 1: In this stage PSK signal is demodulated by using coherent carrier signal

- Stage 2: In this stage the o/p of detector is passing through low pass filter to generate inform'n bits

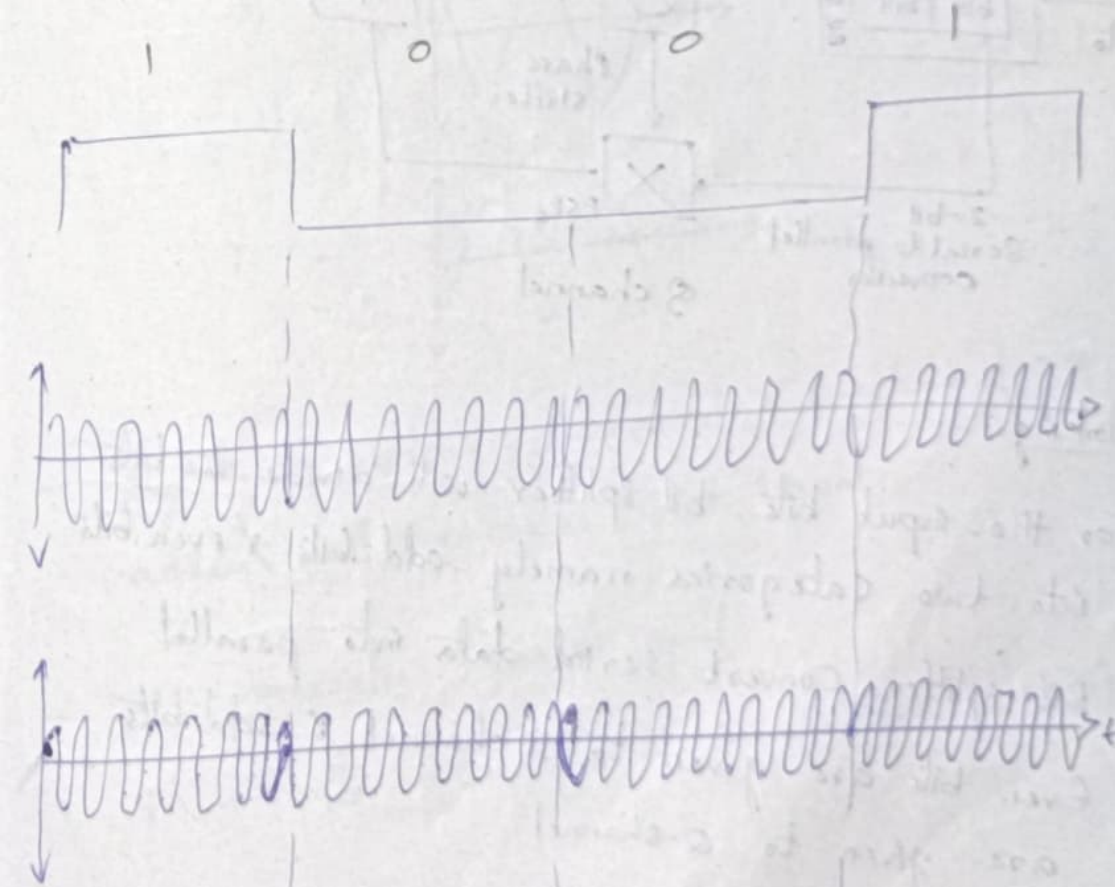
Example: 1 0 0 1 ASK



FSK



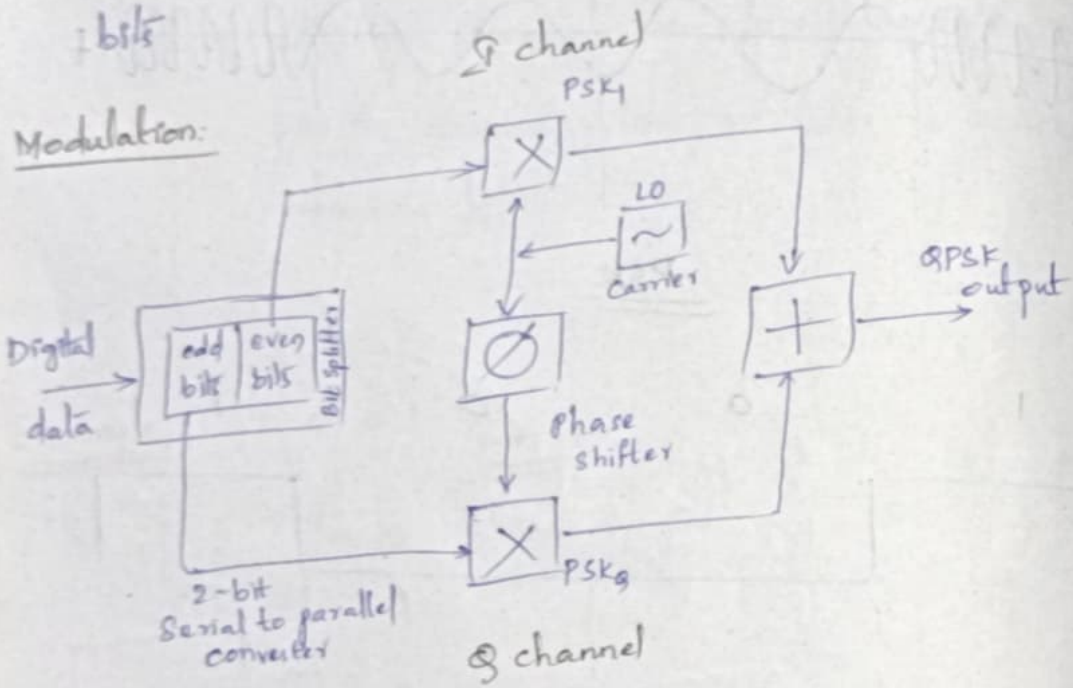
PSK



QPSK (Quadrature phase shift keying) - mobile comm

- The process of generating quadrature phase for the given information bits
- In General every QPSK contains two bit Combination i.e
  00 → even
  01 → odd
  10 → even
  11 → odd
- In QPSK, the I/p bits are divided into even & odd bits

Modulation:



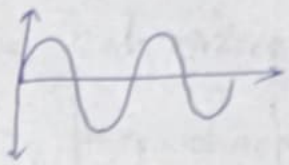
Working:

- For the input bits, bit splitter will divide the bits into two categories namely odd bits & even bits
- Bit splitter convert serial data into parallel
- Even bits are given to I channel & odd bits are given to Q-channel

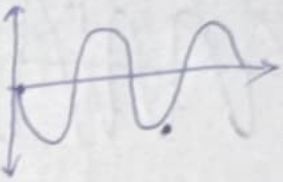
  I → Inphase
  Q → quadrature

- In I-channel the even bits is used for generating PSK signal.
- Similarly, In Q-channel odd bits are used for generating PSK signal.
- In I-channel the o/p contains even PSK signal

00 -

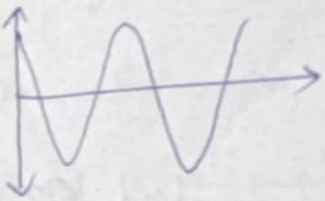


10 -

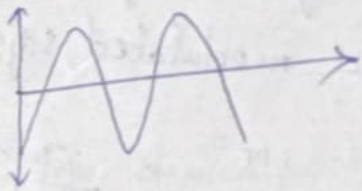


- In Q-channel the o/p contains odd PSK signal.

01 -



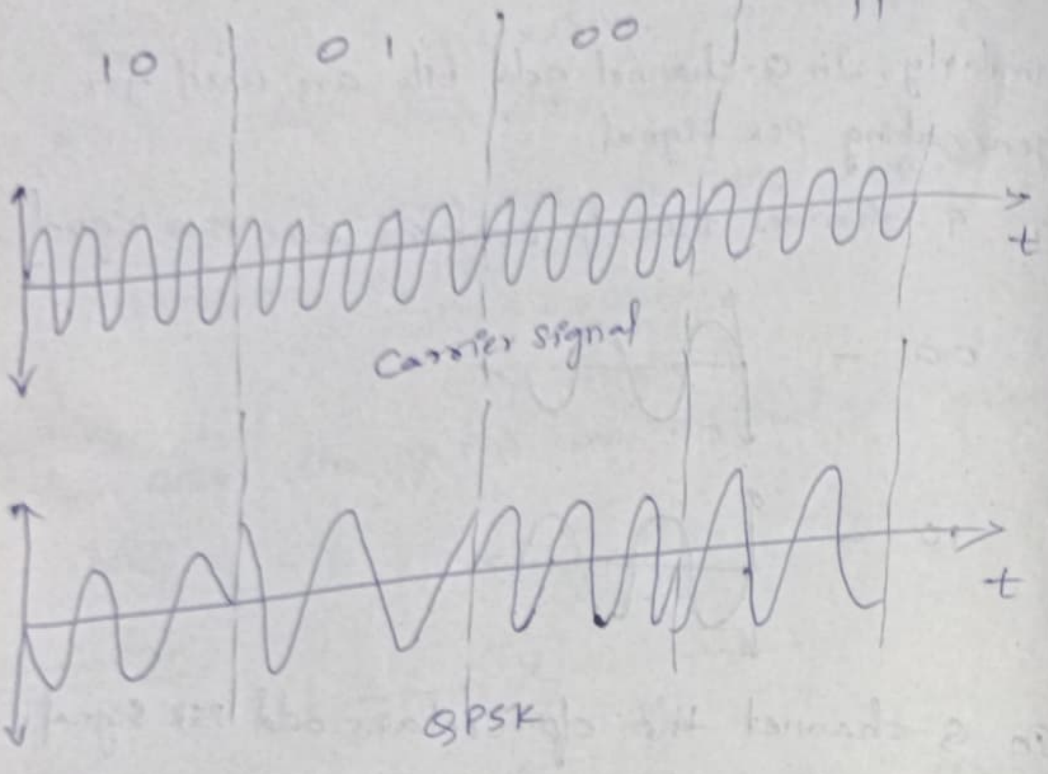
11 -



- By using adder I-channel & Q-channel are added and generates QPSK signal

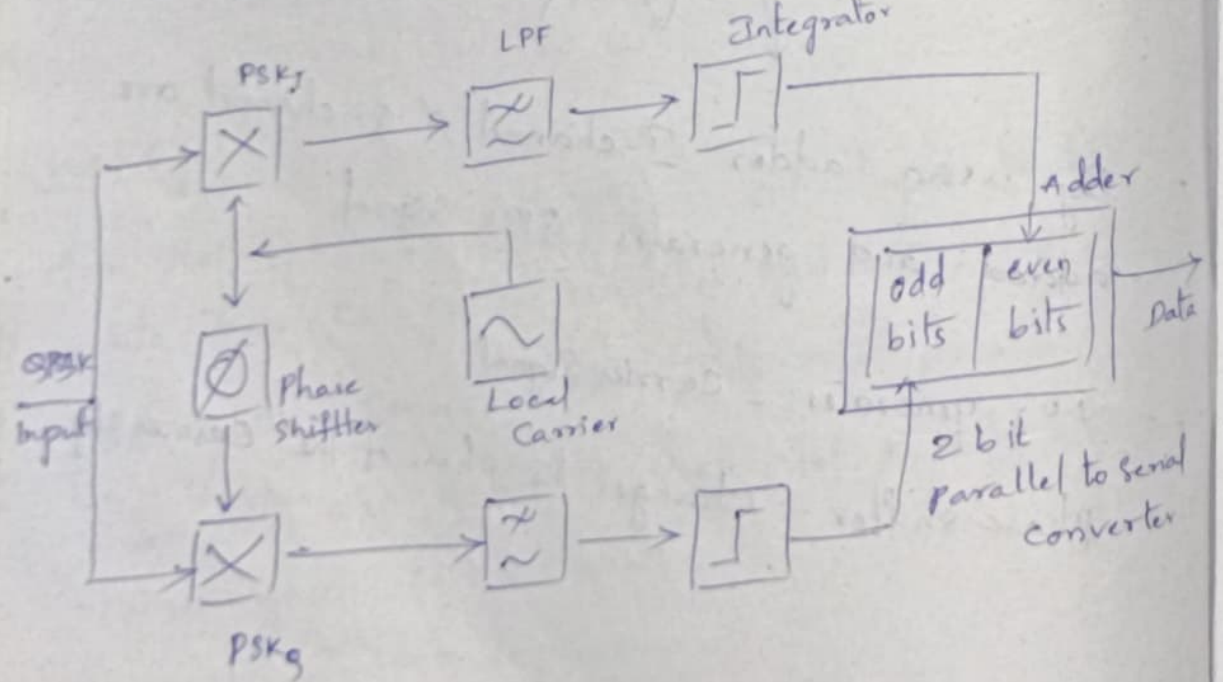
- LO - generates - carrier signal
- Phase shifter - changes the phase of the carrier sig

10010011



QPSK demodulation:

The process of generating original information bits from QPSK modulated signal



Working:

- Whenever QPSK signal presented at the demodulator it divides into two parts namely: I-channel
  Q-channel
- I-channel: In this channel the i/p QPSK is demodulated by using Inphase Carrier signal (or) Synchronous Carrier signal
- Q-channel: In this channel the i/p QPSK signal is demodulated by using out of phase Carrier signal
- phase shifter: The device which convert phase of a Carrier signal
- Low pass filter: By using low pass filter low frequency signal is allowed & it removes high frequency signal
- Integrator: The device which converts i/p signal into binary bits
- Adder: It is used for converting parallel bits into serial bits

UNIT - 2

* Fm - frequency modulation

mark - f_m
space - f_s
$\Big\rangle f_d$ $\quad f_d = f_m \pm f_s$

$$\text{Modulation index } (\beta) = \frac{f_d}{\text{frequency of msg signal}}$$

Q) Calculate freq devn in a FM system with msg freq and modulation index is given as

$m(t) = 4\cos 40\pi t$

$\beta = 2.5$

Given data

msg signal $m(t) = 4\cos 40\pi t = A_m \cdot \cos 2\pi f_m t$

$A_m = 4V$

$f_m = 20Hz$

modulation index $(\beta) = 2.5 \Rightarrow \beta = \frac{f_d}{f_m}$

$$2.5 = \frac{f_d}{20}$$

$$f_d = 2.5 \times 20$$

$$= 50$$

Draw the spectrum of AM and FM Systems with following msg & carrier parameters

$m(t) = 8\cos 400\pi t$

$c(t) = 4\cos 8000\pi t$

Given Data.

msg signal $m(t) = 8\cos 400\pi t$

$A_m = 8\,V$

$f_m = 200\,Hz$

Carrier signal $c(t) = 4\cos 8000\pi t$

$A_c = 4$

$f_c = 4000\,Hz$

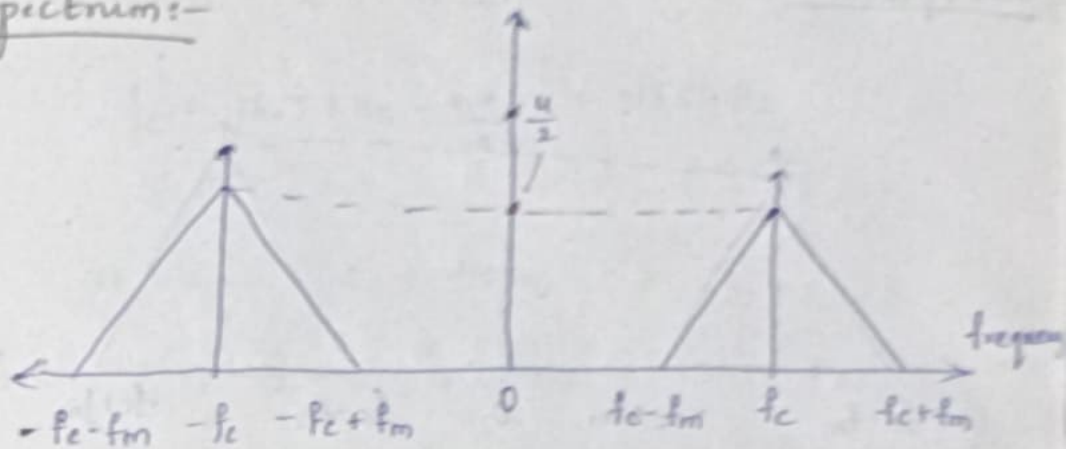
$f_c = 4\,KHz$

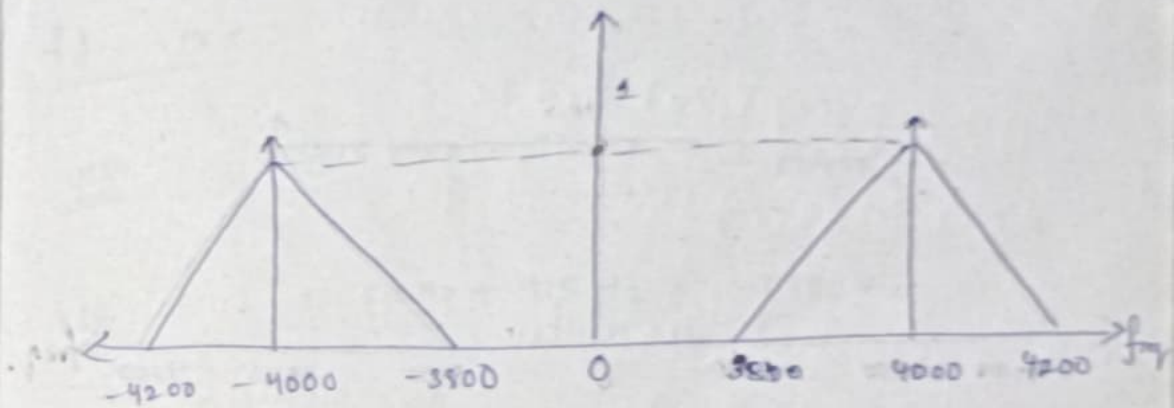
Modulation index $(\mu) = \frac{A_m}{A_c} = \frac{8}{4} = 2$

frequencies USB $= f_c + f_m = 4000 + 200 = 4200\,Hz$

LSB $= f_c - f_m = 4000 - 200 = 3800\,Hz$

AM Spectrum:-



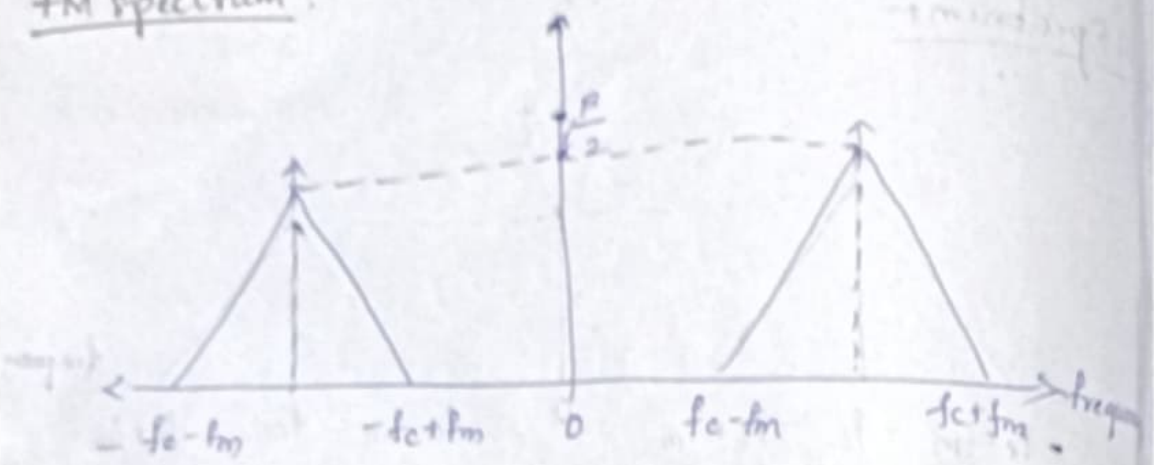


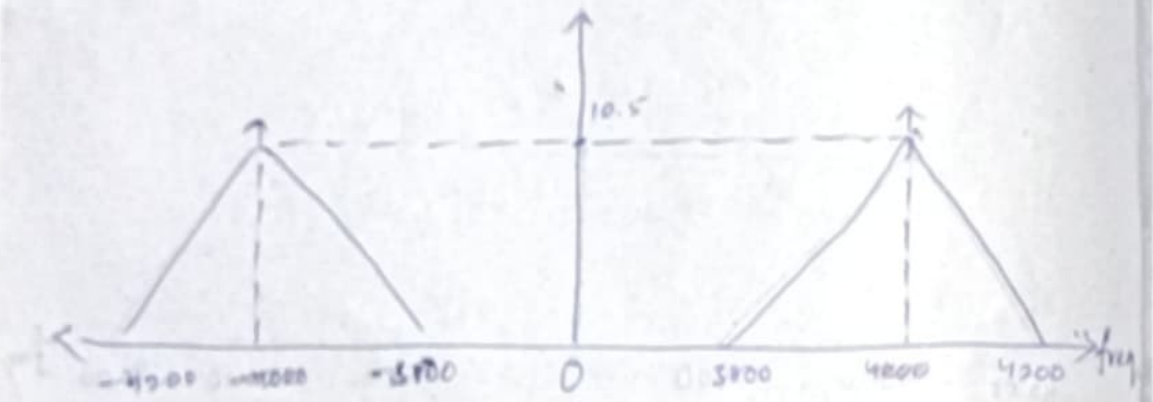
Modulation (β) = $\frac{f_d}{f_m}$

$f_d \Rightarrow$ 4200 USB
or
3800 LSB

$$\beta = \frac{4200}{200} = 21$$

FM Spectrum:





Q) Measure max & min frequencies of a 'fm' System having fd (freq. devn) of ± 12.5 KHz Its operating freq is 915 Hz.

Given Data

frequency deviation (fd) = ± 12.5 KHz

Operating frequency (fm) = 915 Hz

frequency deviation (fd) - USB = fc + fm

LSB = fc - fm

* Am - Amplitude modulation

Carrier signal - high freq

Msg signal - low freq

$M(t) = Am \cdot \cos 2\pi fmt$

$c(t) = Ac \cdot \cos 2\pi fct$

Modulation index $(\mu) = \frac{Am}{Ac}$

Upper frequency (USB) = $fc + fm$

lower frequency (LSB) = $fc - fm$

Q) In a standard AM system Calculate modulation index and Varies frequency parameters for a message signal $2\cos 50\pi t$ & carrier signal, $4\cos 60\pi t$

Given data:

Msg signal $M(t) = 2\cos 50\pi t$

Carrier signal $c(t) = 4\cos 60\pi t$

Msg parameters:

Amplitude $(Am) = 2V$

frequency $(fm) = 25\ Hz$

Carrier parameters:

- Amplitude (Ac) = 4V
- frequency (fc) = 30 KHz = 30,000 Hz

Modulation (μ) = $\frac{Am}{fd} = \frac{2}{4} = 0.5$

Frequencies: USB = fc + fm = 30,000 + 25
= 30,025 Hz //

LSB = fc − fm = 30,000 − 25
= 29,975 Hz //

9) Calculate total power in AM system having Carrier power 30 Watts. Consider the amplitudes of AM system is given as

AM = 15 V, Ac = 7V

Total Power or transmitted power

$$P_t = P_c \left[1 + \frac{\mu^2}{2}\right]$$

Given data.

Carrier power (P_c) = 30 watts

Amplitude of msg signal $(A_m) = 5V$

Amplitude of Carrier signal $(A_c) = 7V$

$\therefore$ Modulation Index $(\mu) = \frac{A_m}{A_c} = \frac{5}{7} = 0.71$

$\therefore$ Total power $P_t = P_c \left[1 + \frac{\mu^2}{2}\right]$

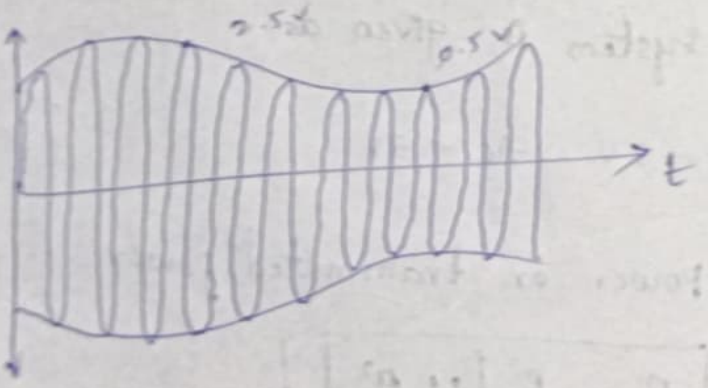
$$P_t = 30 \left[1 + \frac{(0.7)^2}{2}\right]$$

$$= 37.3 \text{ watts}$$

Q) Construct AM system for the given amplitude Values & calculate modulation Index.

$V_p - p(max) = 2.5V$

$V_p - p(Min) = 0.5V$



Modulation Index $(\mu) = \frac{V_p max - V_p min}{V_p max + V_p min}$

$$= \frac{2.5 - 0.5}{2.5 + 0.5} = 0.66$$

* Note: If modulation Index (μ) < 1 → under modulation

If modulation index (μ) = 1 → perfect modulation

$\mu > 1$ → over modulation

* PCM

* 8) An Information signal transmitted through a digital channel having parameters -6v to +6v amplitude with a input bits of 14 bits

a) Measure no. of binary codes

b) Calculate no. of voltage levels

c) Find the resolution of digital bits.

Input parameters

Amplitude = -6v to +6v

$V_{p-p} = 12V$

Input bits (N) = 14

a) The no. of bits in PCM (or) Digital channel

$(2^N) = 2^{14} = 16384$

b) The no. of voltage levels (V_N) (or) quantized levels

$(2^N - 1) = 16383$

c) resolution (R) = $\frac{V_{p-p}}{V_N}$

$= \frac{12}{16383} = 7.324 \times 10^{-4}$

$= 0.732 \times 10^{-3} V$

$= 0.73 mV$

8) In a communication system by using A/D (Analog to digital or PCM) Converter that uses 8 bits of input. The information signal having peak voltage of -5 to 5 V. Calculate a) No. of discrete levels
b) No. of quantized levels
c) Measure digital resolution

Amplitude : -5 to 5 V

$V_{p-p} = 10 V$

Input bits = 8 bits = N

a) $2^N \Rightarrow 2^8 = 256$

b) $2^N - 1 = 255$

c) $R = \frac{V_{p-p}}{V_N} = \frac{10}{255} = \frac{1}{25.5} = 0.0392 V$

$f_d = +12.5$

USB $12.5\,kHz = f_c + 915\,Hz$

$\therefore f_c = 12.5\,kHz - 915\,Hz = 11585\,Hz$

LSB $12.5\,kHz = f_c + 915\,Hz$

$f_c = 12.5\,kHz + 915\,Hz = 13415\,Hz$

$f_d = -12.5$

USB $-12.5\,kHz - 915\,Hz = -13415\,Hz$

LSB $-12.5\,kHz + 915\,Hz = -11585\,Hz$

Max and Min freq: $\pm 11585\,Hz$

$\pm 13415\,Hz$

3 Telephone communication System

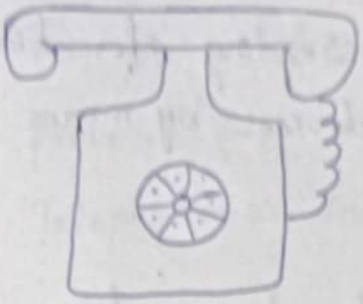
Telephone: Tele means long distance. A telephone is a device used for long distance communication

- Telephone uses AM modulation for long distance communication in which the information is transmitted by means of physical medium.
- The physical mediums are like copper wires. twisted pairs. co-axial cable. Optical fibre

Telephone System:

- It is a combination of various telephone devices used for a specific application
- In General, telephone System contains Several blocks

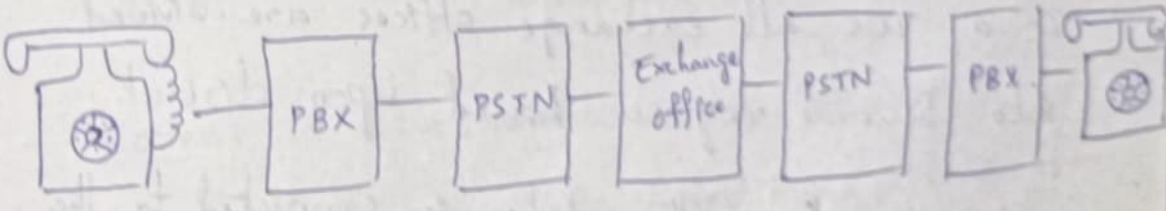
1. Input [Mic] Transducer
2. Output (speaker) Transducer
3. Hook
4. Dial pad
5. Wired connector.



Telephone

Telecommunication system

- The system which is used for long distance communication is called TCS.
- In General, TCS contains various major & minor blocks.
- Major blocks are used for information signals and Minor blocks are used for connections.



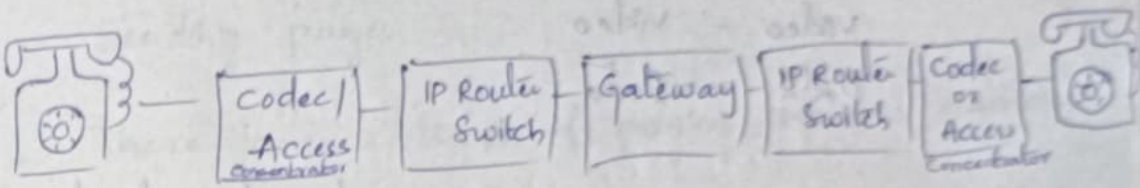
BLOCK DIAGRAM of TCS.

Working:

- Telephone device is used for sending information from one device to another device by means of channel/ Medium.
- PBX: PBX contains several internal connections belongs to one region
- PSTN: PSTN stands for "public switching telephone Network" is used for connecting several regions into one region.
- Exchange office: It is a building which contains several switches to connect all PBX (or) PSTN
  * Exchange office used for billing purpose
  * EO is also used for status verifications
- In a TCS all exchange offices are divided into several regions based upon district
- In TCS, the other side is connected to the destination i.e, PBX, PSTN, Telephone

Internet Telephone:

The process of sending information via internet protocol such a module is called Internet Telephone or Internet telephony



Working:

1. Telephone: The device used for sending information from source to destination is called as Telephone which contains: - Input transducer
   Output transducer
   Dial pad
   Hook
   Wired connector

2. Codec: It is a combination of Software & Hardware tools used for identifying Nature of call (voice, video)
   - It contains 2 major blocks namely:
   Access & concentrator

3) Access: It is a subserver used for allowing all types of input signals (voice, data, video)

iii) Concentrator: It is a software used for executing a particular task

ex:- voice - voice
video - video
data - Data

3. IP Router switch: IP stands for Internet protocol

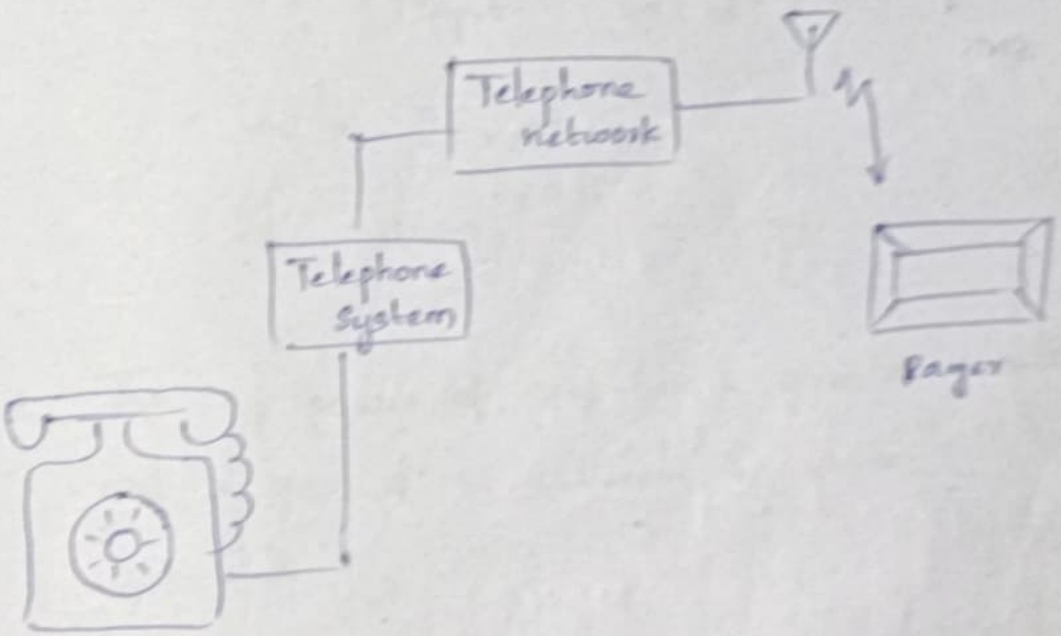
- The purpose of switch is to convert multiple inputs into single output or viceversa.
- Every router contains a predefined data or transport medium

4. Gateway: It is a hardware device used for connecting various output devices based upon its application

- The Gateway is used for billing purpose

Paging System:

- It is a wireless telecommunication system used for sending simple text msgs called as page
- It is a one way communication channel in which a telephone system is used for sending pages
- There are 2 types of paging systems namely
  i) Manual paging
  ii) Automatic paging



i) Manual paging: In this type subscriber need to visit telephone office to send page. The telephone exchange office sends a predefined TONE to the pager

ii) Automatic paging: In this type the subscriber need not to visit telephone exchange office to send page. but, Generally a telephone system sends a 'Alert' tone

Types of Alert tones:

Based upon type of output device there are various alert tones namely:

- voice
- MMS
- string Tone
- SMS

UNIT-3

Q) In a telecommunication system, there are 25 links which are connected to 5 telephone systems. Measure size of the switch & efficiency of the switch

Given data.

No. of links (L) = 25

No. of telephones = (N) = 5

a) Size of the switch (S) = $\frac{L(L-1)}{N} = \frac{25(25-1)}{5}$

$= \frac{25 \times 24}{5}$

$= 120$

b) Efficient (η) = $\frac{S}{N}(N-1) \times 100 = \frac{120}{5} \times 4 \times 100 = 9600$

Q) In a telecom system there are 250 links which are connected to 10 telephone systems. Calculate efficiency of the system if the no. of telephones are increased to 25.

Given data.

$L = 250, \quad N = 10$

a) $S = \frac{L(L-1)}{N} = \frac{250(250-1)}{10} = \frac{250 \times 249}{10} = 622$

b) $\eta = \frac{S}{N}(N-1) \times 100$

$= \frac{6225}{10}(9) \times 100$

$= 6225 \times 90 = 560250$ //

if $10 \longrightarrow 25$

$\therefore$ efficiency for 25 telephones $\eta = \frac{560250}{25}$

$\eta = 22410$ //

Note: if $10 \rightarrow 5$

then 560250×25 ✓

*** Q: In a communication system a modulating signal $4\cos 100\pi t$ is modulated interms of Amplitude with a high frequency signal $8\cos 500\pi t$ Justify that AM spectrum is more efficient than FM spectrum

Given,

$m(t) = 4\cos 100\pi t$

$c(t) = 8\cos 500\pi t$

msg signal $m(t) = 4\cos 100\pi t$

$A_m = 4V$

$f_m = 50Hz$

Carrier signal $c(t) = 8\cos 500\pi t$

$A_c = 8$

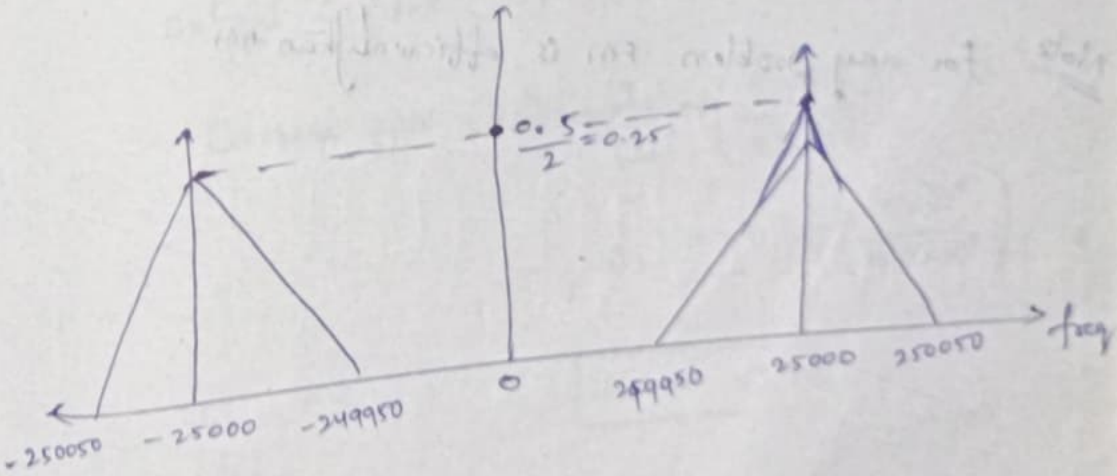
$f_c = 250Hz$

Modulation index $(\mu) = \frac{A_m}{A_c} = \frac{4}{8} = \frac{1}{2} = 0.5$

frequencies USB $= f_c + f_m = 250000 + 50 = 250050\ Hz$

LSB $= f_c - f_m = 250000 - 50 = 249950\ Hz$

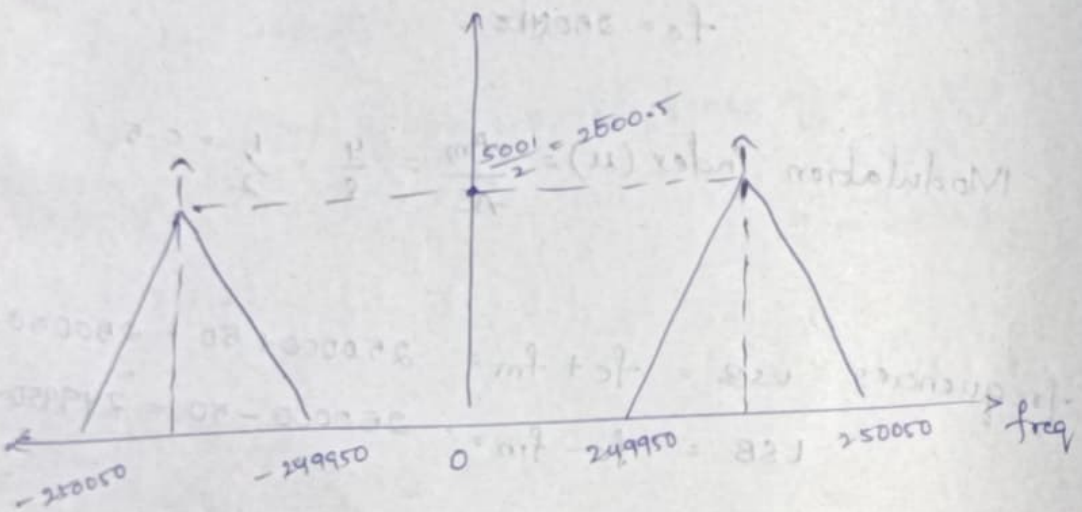
AM spectrum



Modulation (p) = $\frac{f_d}{f_m}$

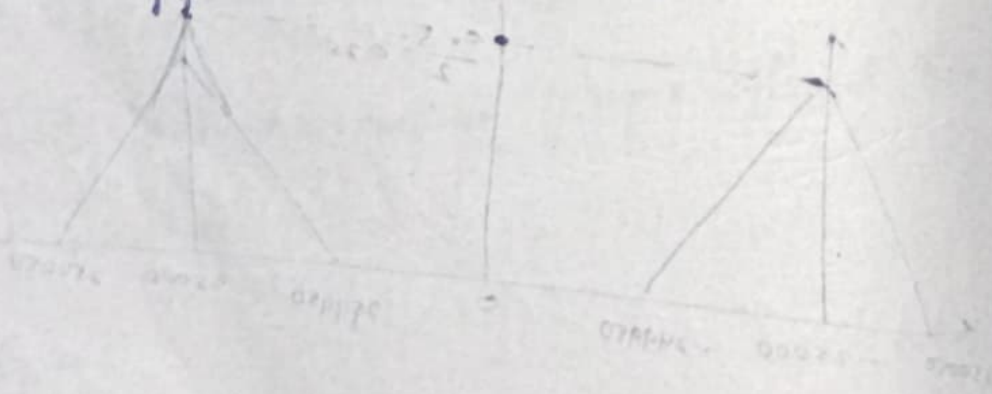
$= \frac{250050}{50} = 5001$

Fm spectrum



Efficiency: FM is efficient modulation

Note: For any problem, FM is efficient than AM



Q: In a communication system for the following values. The response of the system is

a) 5 V , 10 V

b) 4.5 mA , 5 μA

c) 20 mwatts , 10 μwatts

a) input voltage (V_i) = 5 V

output voltage (V_o) = 10 V

Voltage gain in dB (A_V) = $20 \log \left(\frac{V_o}{V_i}\right)$

$A_V = 20 \log \left(\frac{10}{5}\right)$

$A_V = 20 \log 2 = 20 \times 3010$

$\boxed{A_V = 6.02 \text{ dB}}$

∴ gain

b) Input current (I_i) = 4.5 mA = 4.5×10^{-3} A

output current (I_o) = 5 μA = 5×10^{-6} A

Current gain (A_I) = $20 \log \left(\frac{I_o}{I_i}\right) = 20 \log \left(\frac{5 \times 10^{-6}}{4.5 \times 10^{-3}}\right)$

$A_I = 20 \log \left(\frac{5 \times 10^{-6}}{4.5 \times 10^{-3}}\right)$

$\boxed{A_I = -59 \text{ dB}}$

∴ Attenuation

c) input power = (P_i) = 20 mwatts

output power = (P_o) = 10 μ watts

power gain in dB $(A_p) = 10 \log\left(\frac{P_o}{P_i}\right)$

$$A_p = 10 \log\left(\frac{10 \times 10^{-6}}{20 \times 10^{-3}}\right)$$

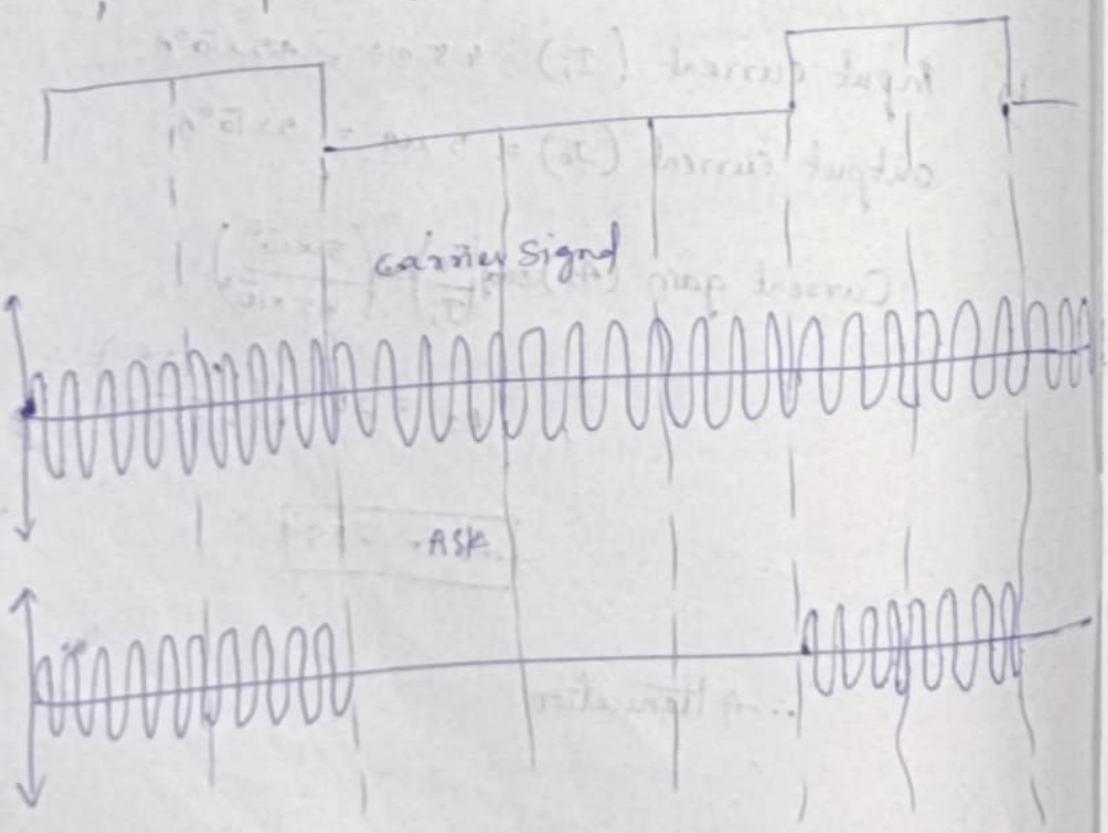
$$\boxed{A_p = -33 \text{ dB}}$$

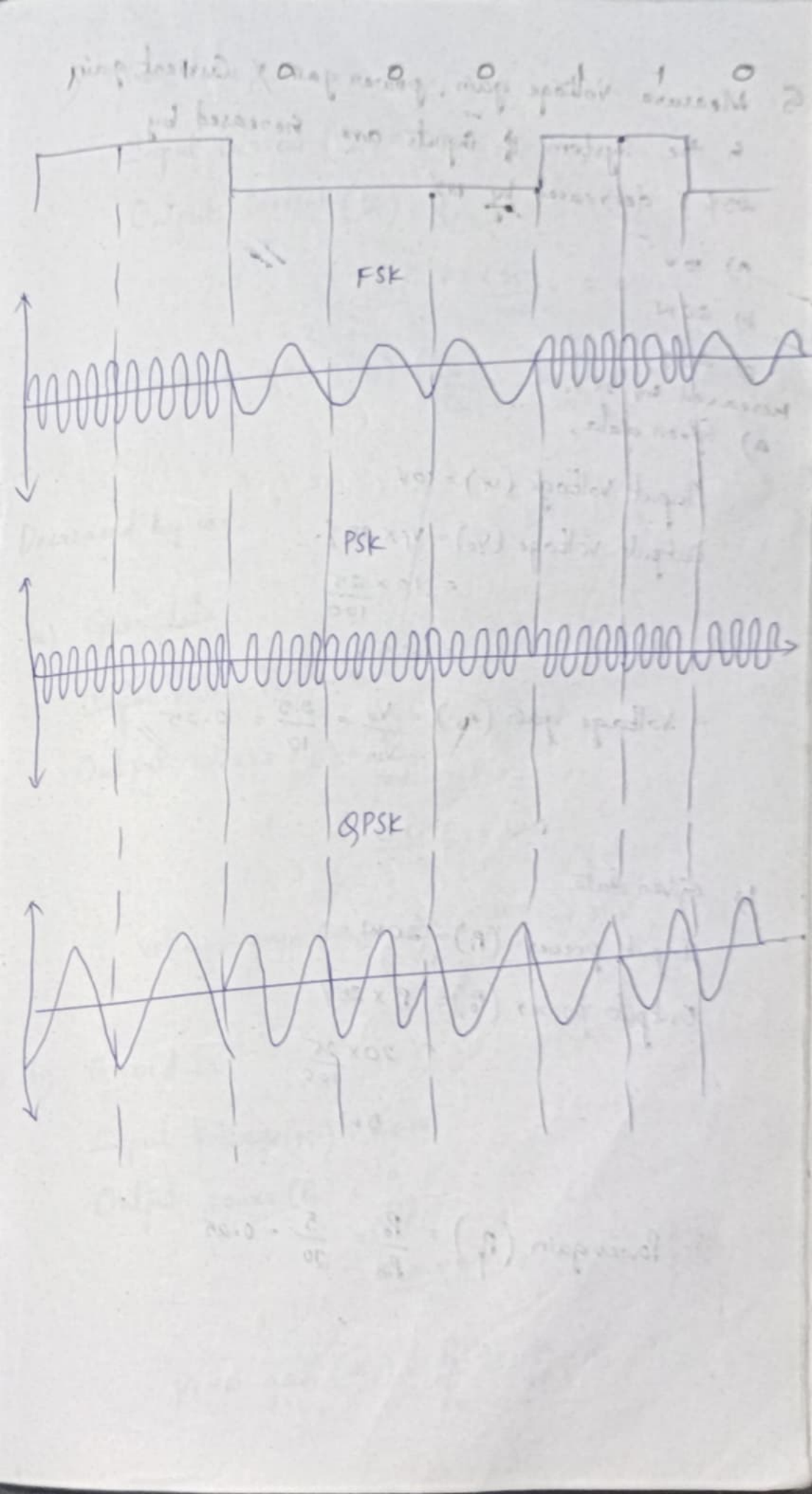
∴ Attenuation

Q: For a given binary bits Construct ASK, FSK, PSK.

QPSK

1 1 0 0 0 1 1 0




FSK
PSK
QPSK

Q. Measure voltage gain, power gain & Current gain in the system if inputs are increased by 25% & decreased by 10%.

a) 10 V

b) 20 W

c) 25 A

increased by 25%.

a) Given data,

Input Voltage (V_i) = 10V

Output voltage (V_o) = $V_i \times 25\%$

$= 10 \times \frac{25}{100}$

$= 2.5\ V$

$\therefore$ Voltage gain (A_V) = $\frac{V_o}{V_{in}} = \frac{2.5}{10} = 0.25$ //

b) Given data.

Input power (P_i) = 20W

Output power (P_o) = $P_i \times 25\%$

$= 20 \times \frac{25}{100}$

$= 5W$

$\therefore$ Power gain (P_p) = $\frac{P_o}{P_{in}} = \frac{5}{20} = 0.25$

c) Given data,

Input current (I_i) = 25A.

Output Current (I_o) = $I_i \times 25\%$

$= 25 \times \frac{25}{100} = 6.25$

$\therefore$ Current gain (A_I) = $\frac{I_o}{I_{in}} = \frac{6.25}{25} = 0.25$ //

Decreased by 10%.

a) Given data

Input voltage (V_i) = 10V

Output voltage (V_o) = $\frac{V_i}{10\%}$

$= \frac{10 \times 100}{10} = 100$

$\therefore$ Voltage gain (A_V) = $\frac{V_o}{V_{in}} = \frac{100}{10} = 10$ //

b) Given data.

Input voltage (P_i) = 20W

Output power (P_o) = $\frac{P_i}{10\%}$

$= \frac{20 \times 100}{10} = 200$

$\therefore$ Power gain (A_P) = $\frac{P_o}{P_{in}} = \frac{200}{20} = 10$ //

c) Given data.

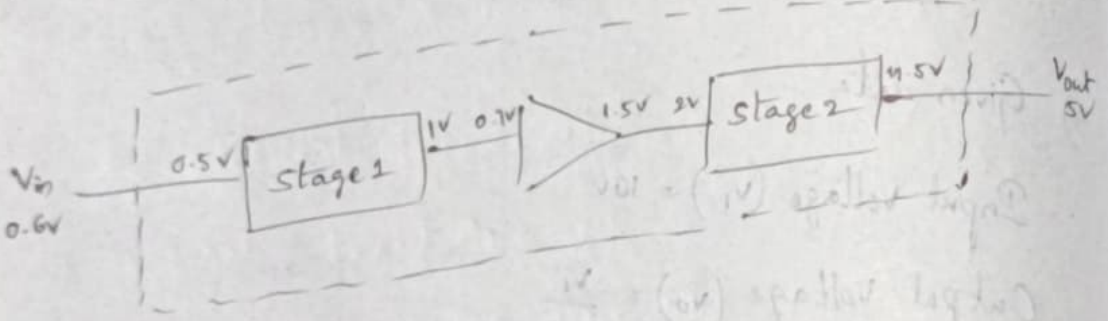
Input Current (I_i) = 25A

Output Current (I_o) = $\frac{I_i}{10\%}$

$= \frac{25 \times 100}{10} = 250$

$\therefore$ Current gain (A_I) = $\frac{250}{25} = 10$ //

Q: In a given system measure gain & Attenuation



stage

(I) Input voltage (V_i) = 0.5V

Output voltage (V_o) = 1V

Voltage gain = $20 \log \left(\frac{V_o}{V_i}\right)$

$= 20 \log \left(\frac{1}{0.5}\right) = 6.02$ //

(II) Input Voltage (V_i) = 0.7V

Output Voltage (V_o) = 4.5V

Voltage gain (A_V) = $20 \log \left(\frac{V_o}{V_i}\right)$

$= 20 \log \left(\frac{1.5}{0.7}\right) = 6.6$ //

(III)

Input voltage (V_i) = 2V

Output voltage (V_o) = 4.5V

Voltage gain (A_V) = $20\log\left(\frac{V_o}{V_i}\right)$

$= 20\log\left(\frac{4.5}{2}\right) = 7$

Total = I * II * III * So

$= 6.02 * 6.6 * 7 * So$

So ⇒ Input voltage (V_i) = 0.6V

Output voltage (V_o) = 5V

Voltage gain (A_V) = $20\log\left(\frac{5}{0.6}\right) = 18.4$

Total = So × I × II × III

$= 18.4 \times 6.02 \times 6.6 \times 7 \Rightarrow 5117.1816$

Network Fundamentals:

- Network is defined as capability of a device that perform various operations or applications
- In a network all devices are connected by means of a channel.
- In a computer Network, all the devices will satisfies a basic fundamentals
- The Network fundamentals:
  - i) LAN - Local Area N/w
  - ii) CAN - Campus Area N/w
  - iii) MAN - Metropolitan Area N/w
  - iv) WAN - Wide area N/w

Network Services:

There are several services to justify fundamentals of networks in communication namely:

i) OSI - Open Systems interconnection

ii) ISO - International Organization for Standardization

iii) IEEE - Institute of electrical & electronic engineers.

iv) IS - International standards

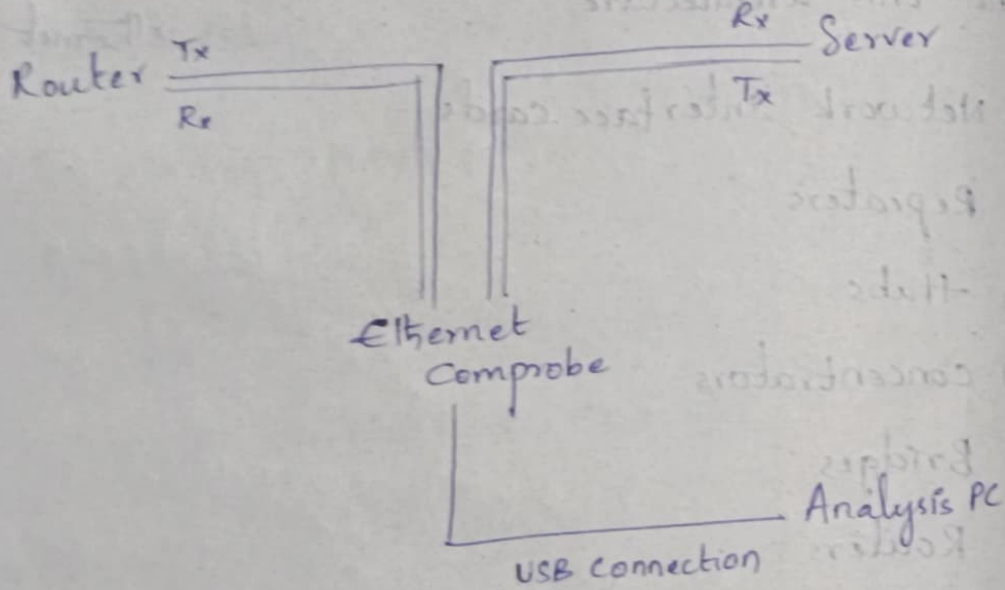
LAN Hardware:

There are several hardware devices presented in the LAN architecture ex- ethernet

i) Network Interface cards
ii) Repeaters
iii) Hubs
iv) concentrators
v) Bridges
vi) Routers
vii) Gateways
viii) Many other special interfacing devices.

Ethernet LANs

- It is designed by using ethernet comprobe along with router and server. By using ethernet LAN hardware is minimized
- In this ethernet LAN, the communication b/w source and destination are predefined



Operation:

- Whenever user want to send data between source and destination. There are several steps involved in LAN
- In ethernet LAN, every data is transmitted through ethernet comprobe

- Ethernet comprobe is a hardware device. which includes all the commands of LAN architecture
- The destination receives all the informations from Server

Drawback:

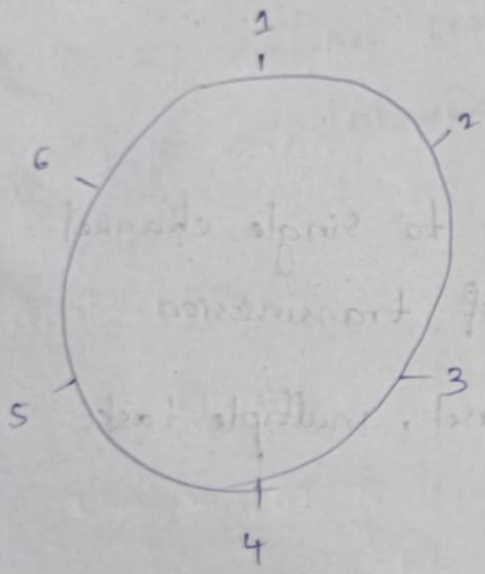
- In this method, due to single channel there is a error of transmission
- Due to single channel, multiple tasks may delay
- Due to server dependence. Collision happens

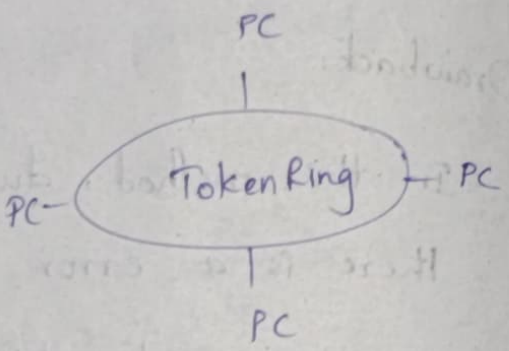
Token Ring LAN:

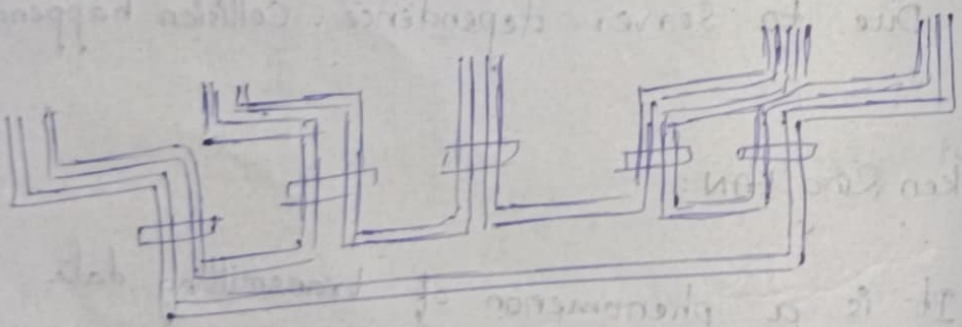
- It is a phenomenon of transmitting data through a ring channel in which the data is always available irrespective of server.
- By using Ring topology, the data is transmitted between single source & single destination, whereas by using token ring topology data is transmitted for several

transmitors and receivers

- By using token ring LAN, efficient transmission of data is possible







UNIT - 1

SATELLITE COMMUNICATION

- It is defined as the process of sending information between two satellites is called as SE.
- If communication happen b/w source and destination through a satellite channel is also called as S.C

Parameters of satellite communication

i) Type of satellite

ii) Orbit

iii) Launching

iv) Application

Satellite: A satellite is a physical object that orbits or rotates about some outer space body.

Orbit: The ability to launch a satellite and keep it in orbit depends upon well-known physical and mathematical laws that are referred to collectively as Orbital dynamics

Launching: If a Satellite were launched Vertically from the earth and then released. it would fall back to earth because of gravity.

Reason: Satellite is launched. it is given both vertical and forward motion.

Applications:

- SC is used in navigation
- Used in RADAR
- Used in Medical
- Used in AI

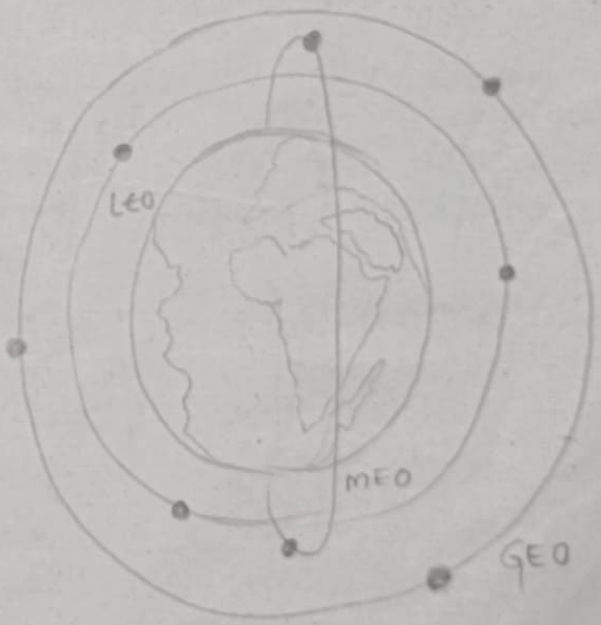
Satellite Orbits:

In satellite communication. the orbits are defined based upon the launch vehicles

There are 4 types of Satellite Orbits based upon its range

1. LEO - Low Earth Orbit
2. MEO - Medium earth Orbit
3. Geosynchronous Orbit - GSO
4. Geostationary Orbit - GEO

Satellite orbit Name	Orbit	Satellite orbit altitude (KM above earth's surface)	Application
Low earth Orbit	LEO	200 - 1200	Satellite phones, Navstar or Global positioning System
Medium Earth Orbit	MEO	1200 - 35790	High speed telephone signals
Geosynchronous Orbit	GSO	35790	Satellite Television
Geostationary Orbit	GEO	35790	Direct broadcast television



Satellite Orbits

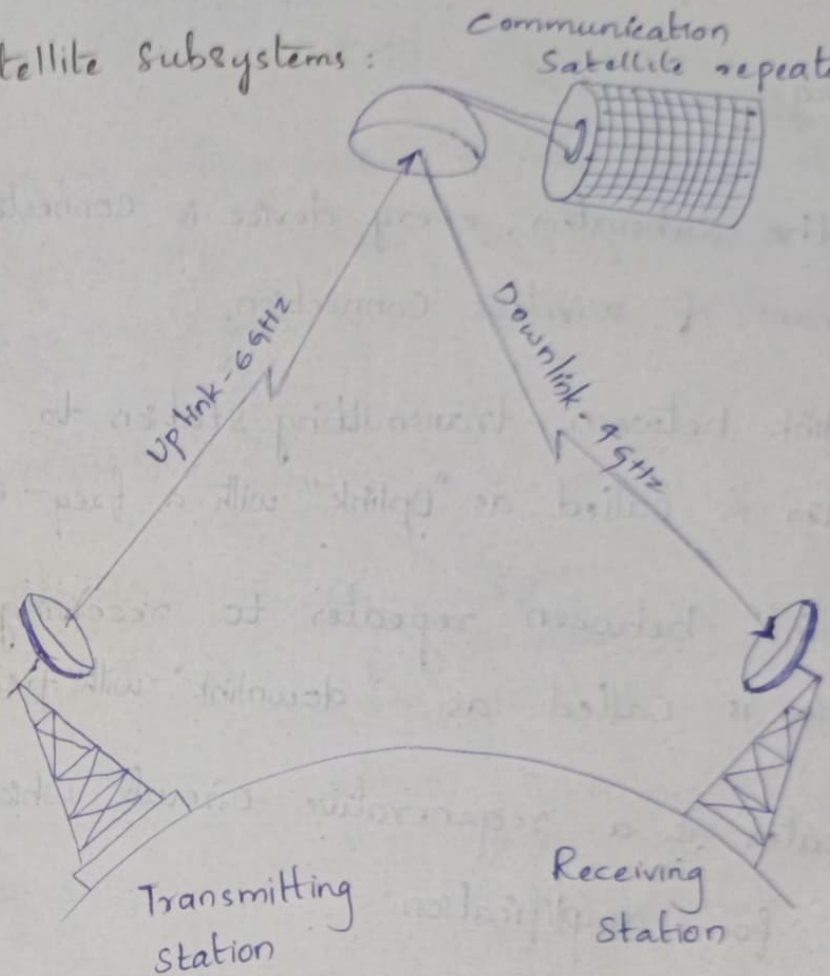
Satellite Frequencies:

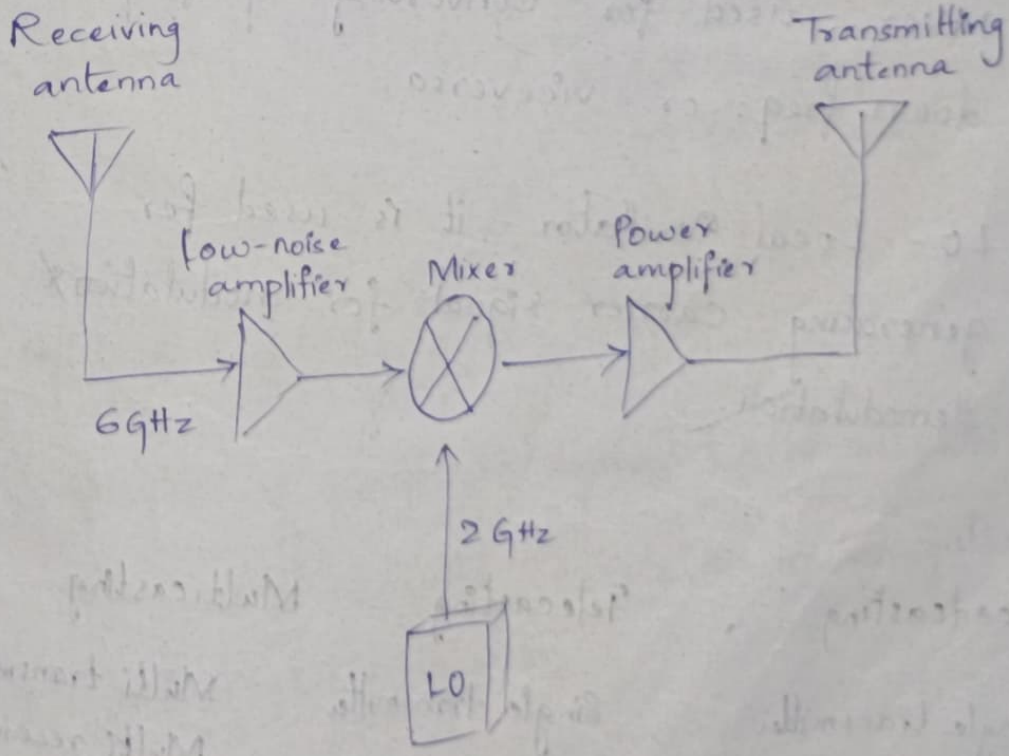
Based upon orbits there are several band of frequencies to communicate various devices in S.C

There are

Band	Frequency
P	225 - 390 MHz
J	350 - 530 MHz
L	1530 - 2700 MHz
S	2500 - 2700 MHz
C	3400 - 6425 MHz
X	7250 - 8400 MHz
Ku	10.95 - 14.5 GHz
Ka	17.7 - 31 GHz
Q	36 - 46 GHz
V	46 - 56 GHz
W	56 - 100 GHz

Satellite Subsystems :





Working:

- In the subsystem, every device is connected by means of wireless connection
- The link between transmitting station to repeater is called as "Uplink" with a freq - 6GHz
- The link between repeater to receiving station is called as "downlink" with freq - 4GHz
- Repeater is a regenerative circuit which is used for amplification
- Repeater contains several amplifiers, mixer
- Mixer - used for converting up freq to down freq or viceversa
- LO - Local Oscillator - it is used for generating carrier signal for modulation & demodulation.

Broadcasting	Telecasting	Multicasting
Single transmitter	Single transmitter	Multi transmitter
Multiple receivers	Single receiver	Multi receiver

Ground Station Satellite - Applications

- Ground station satellite is also known Geo-Synchronous satellite, where there is a Synchronization b/w satellite & Earth station

- Applications:

Little LEOs	–	Paging E-mail Fax
Big LEOs	–	Voice Telephone Low speed data
Broadband LEOs	–	Multimedia conferencing Internet Access Video conferencing Video-Telephony High Speed Data

Global Positioning System (GPS)

- GPS is a navigation System based on satellite
- It has created the revolution in navigation and position location

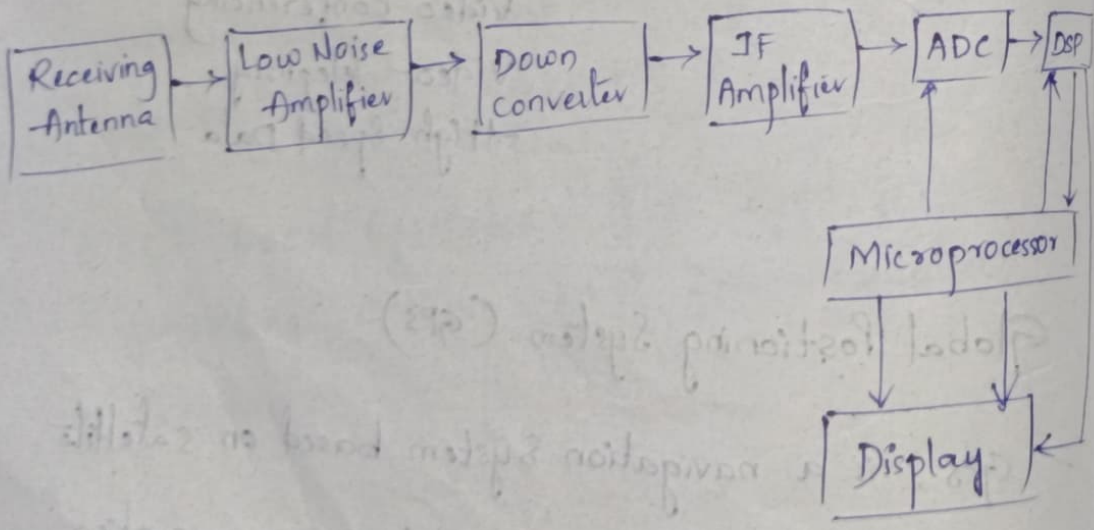
- It is mainly used in positioning, navigation monitoring & surveying appln.
- Major advantage of satellite navigation are real time positioning & timing synchronization.

Two types of GPS codes:

1) Coarse Acquisition code or c/A code → 'L' codes 1530-2700MHz
2) Precise code or P code → 'Ku' codes → 10.95-14.5GHz

These codes are mainly based upon distance from the satellite to receiver

Block Diagram:



Receiving Antenna: receives the satellite signals. It is mainly a circularly polarized antenna

Low Noise Amplifier (LNA): amplifies the weak received signal

Down converter: Converts the freq of received signal to an Intermediate freq (IF) signal

IF Amplifier: amplifies the IF signal

ADC: Analog to Digital Converter

- performs the conversion of analog signal which is obtained from IF amplifier to digital
- Sampling & Quantization blocks - present in ADC

Microprocessor: Performs the calculation of position & provides the timing signals in order to control the operation of other digital blocks

OPTICAL COMMUNICATION

Optical : Studying of light

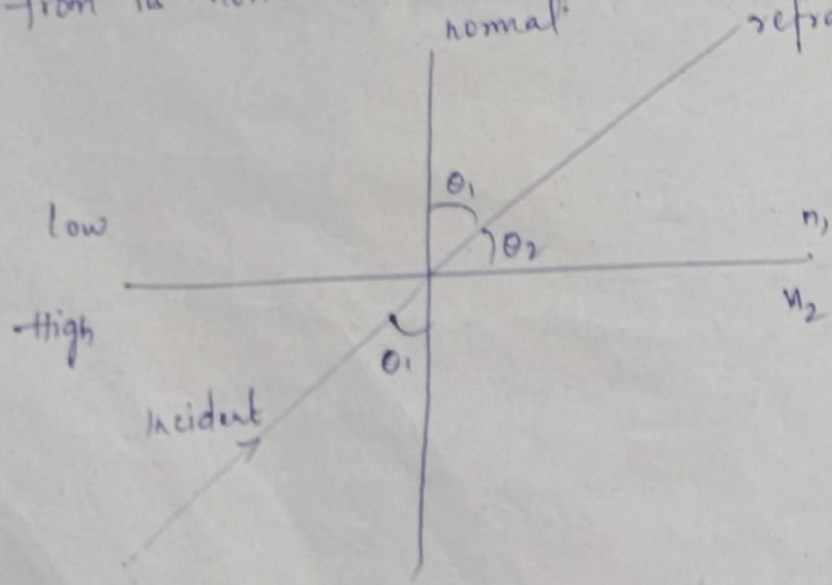
Optical communication: The process of sending information from one point to another point by means of light

Optical fiber cable:

In a communication, if transmitter & receiver are connected by means of optical fiber cable is also known as optical fiber cable

Optical laws:

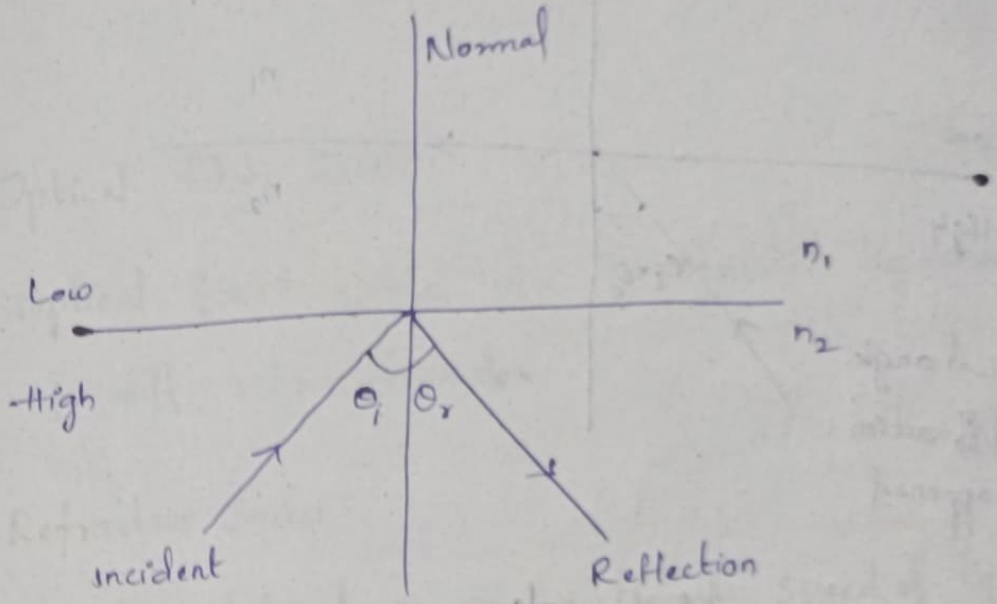
i) Refraction: If light travels from high denser medium to low denser medium, due to its refractive index the light ray will bends away from its normal



where, θ_i → incident angle θ_2 → Angle of refraction

θ_1 → Angle of normal n_1, n_2 → R.I of medium

ii) Reflection: If a light ray travels from high denser medium to low denser medium. due to its refractive index light ray returns back to same medium.



where, θ_i → Incident Angle

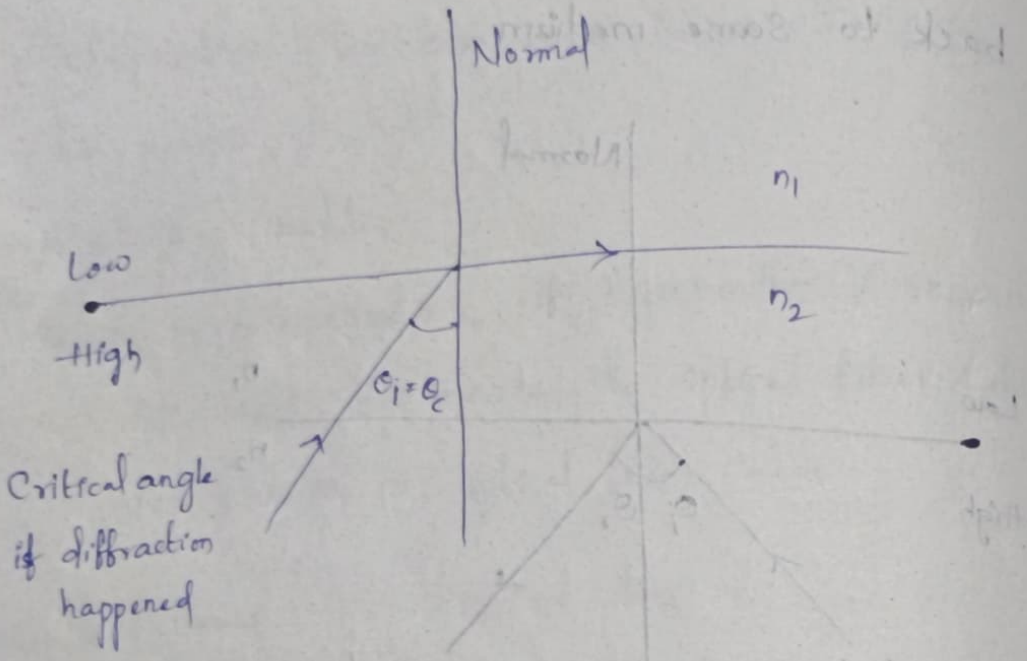
θ_r → Angle of reflection

n_1 → Refractive index medium ①

n_2 → Refractive index medium ②

iii) Diffraction: If light ray travels from high denser medium to low denser medium due to its refractive index. light ray travels along the surface is called as diffraction

- In General, the angle of incidence is called as Critical angle if diffraction happened



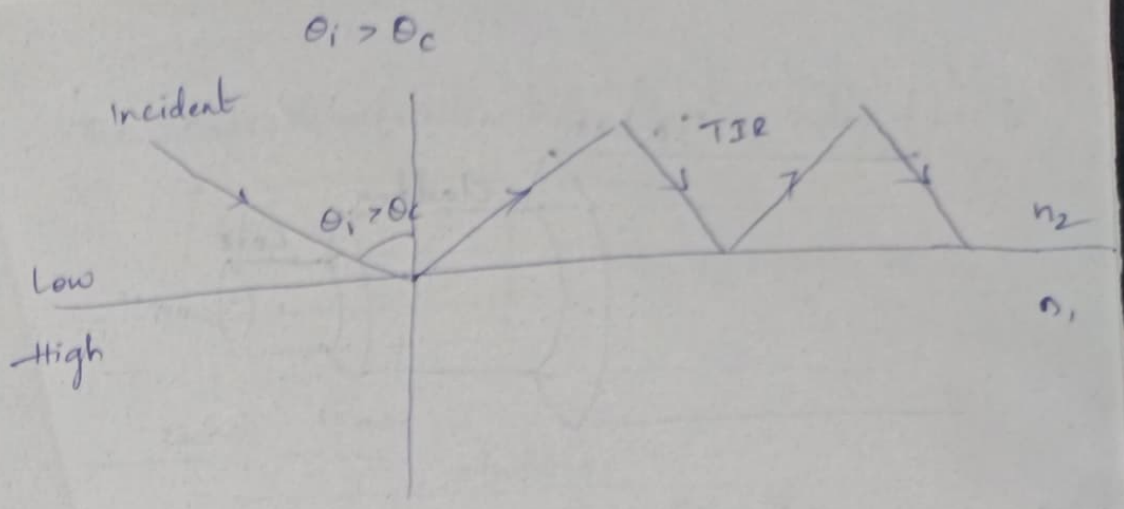
Where, θ_i = Incident angle

θ_c = Critical angle

n_1, n_2 = refractive index mediums

Total internal reflection (TIR)

If a light ray travels from high denser medium to low denser medium. whenever if angle of incident is greater than Critical angle, the light ray totally reflect back of travel along the surface



Optical fiber Cable

Optical fiber cable are constructed by means of diff refractive index

Refractive Index

It is defined as the ratio of speed of light to the velocity of the light in the medium.

$$n = \frac{c}{v}$$

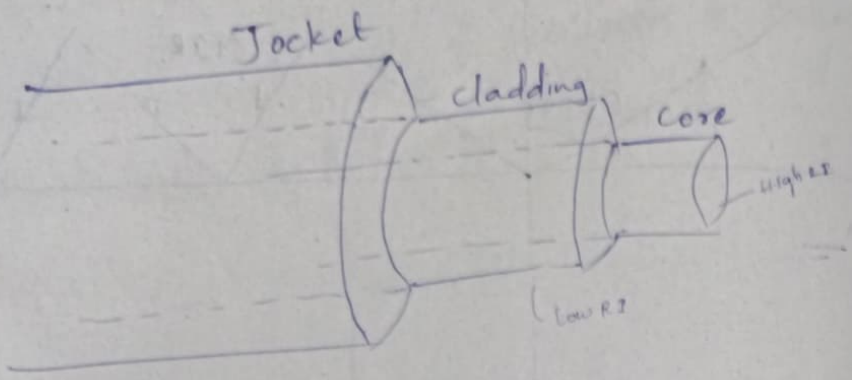
where c = Speed of light = 3×10^8 m/s

v = velocity

Based upon refractive index optical fiber cables are divided into 2 types

i) step index fiber

ii) Grade index fiber



1) Step Index fiber :-

- In optical fiber if refractive index varied in a step size manner such a fiber is called as step index fiber

- In General, the R.I is given as

$$n = \frac{c}{v} \quad \text{---} (1)$$

- In order to increase or decrease the R.I is purely depends upon velocity of light in the medium.

- Let us consider the RI of core

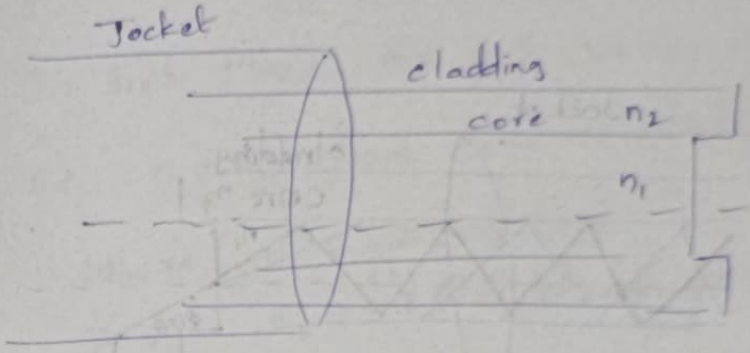
$$n_1 = \frac{c}{v_1} \quad \text{---} (2)$$

Similarly, R.I of cladding

$$n_2 = \frac{c}{v_2} \quad \text{---} (3)$$

- The overall refractive index in step index fiber is

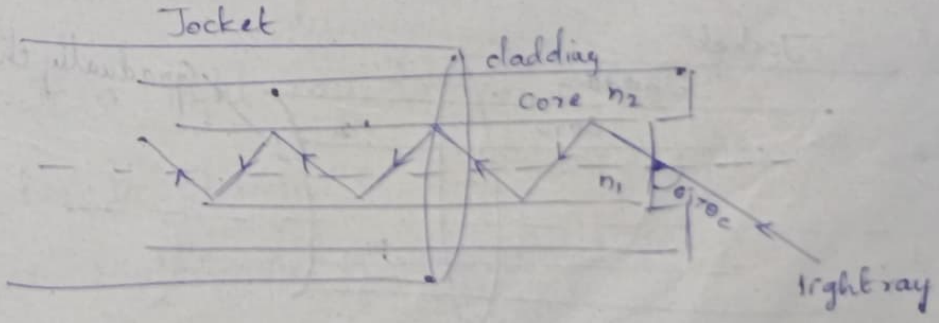
$$N = \frac{c}{v_1} - \frac{c}{v_2}$$



- Step index fiber is divided into 2 types based upon transmission of light ray

i) Single mode step index fiber.

If light ray travels in a single direction such a fiber is called as single mode stepinden fiber.



where θ_i = Incident angle

θ_c = Critical angle

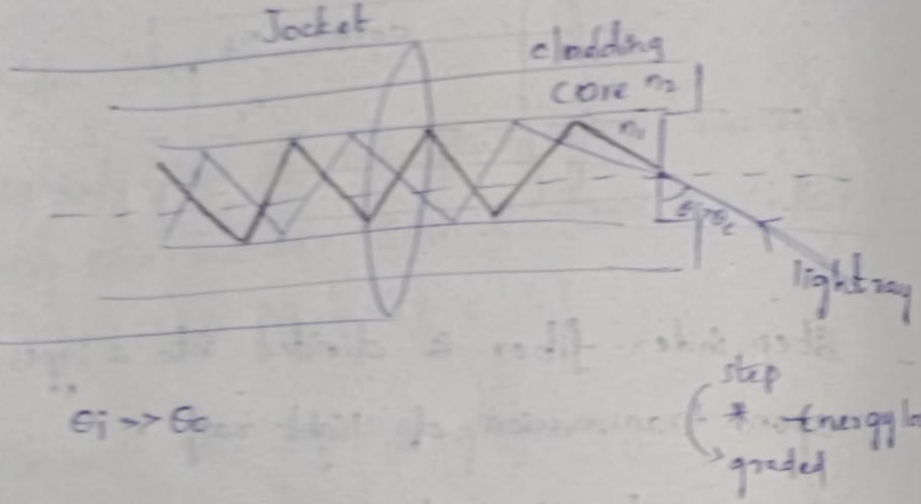
$n_1 > n_2$

n_1 = r.I of core

n_2 = r.I of cladding

i) Multi mode step index fiber:

If a light ray travels in multiple directions Such a fiber is called as Multimode step index fiber.

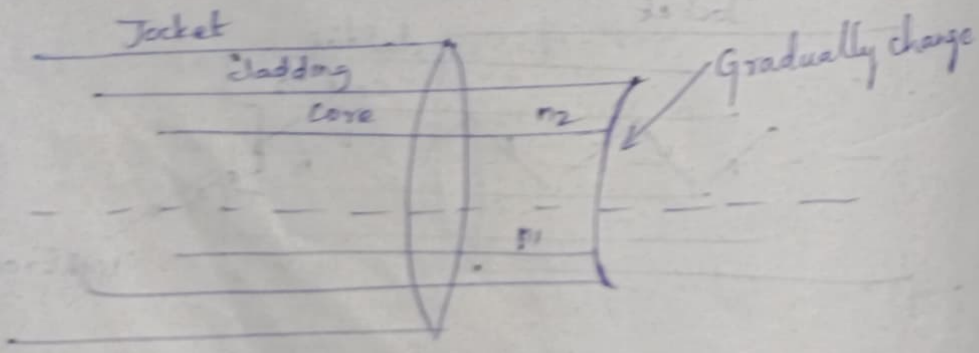


$\theta_i >> \theta_c$

step
* energy loss
graded

2) Graded index fiber:

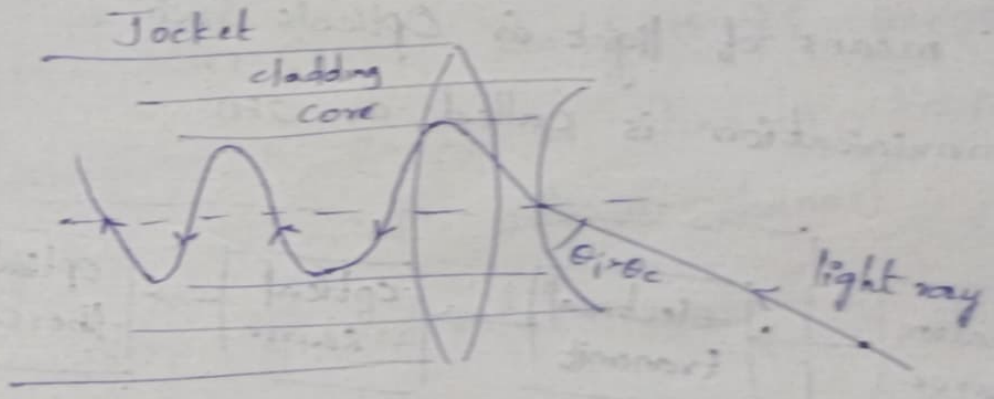
If a fiber if RI is varies gradually Such a fiber is called as Graded index fiber



i) Single mode graded index fiber:

- If light ray travels in single direction in the fiber such a fiber is called single mode graded index fiber
- In such fibers, the RI varies gradually i.e., $n_1 > n_2$ from core to cladding

where $n_1 \rightarrow$ RI of Core
$n_2 \rightarrow$ RI of cladding

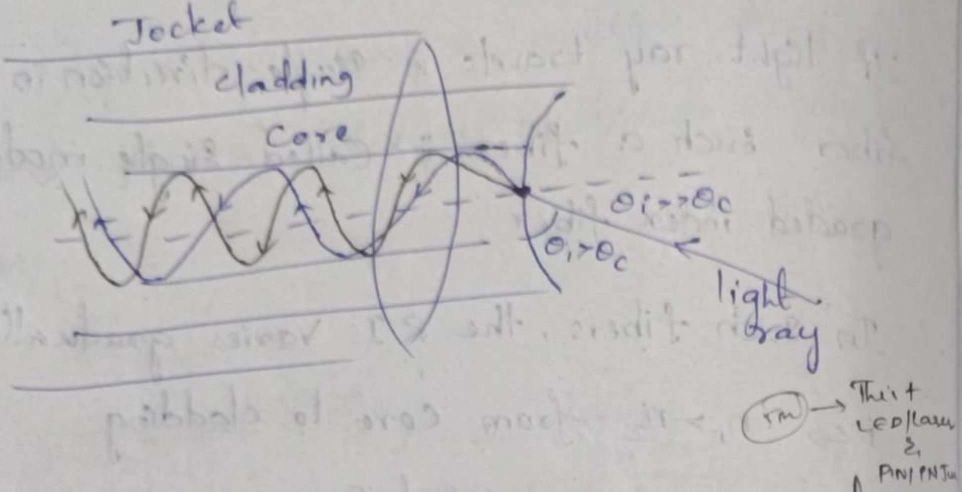


ii) Multimode graded index fiber:

- If a light ray travels in multiple directions due to change in RI such a fiber is called as Multimode graded index fiber

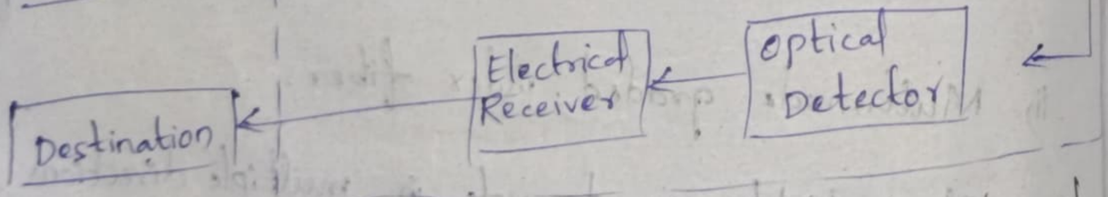
where $\theta_i >> \theta_c$

θ_i — Incident angle
θ_c — Critical angle

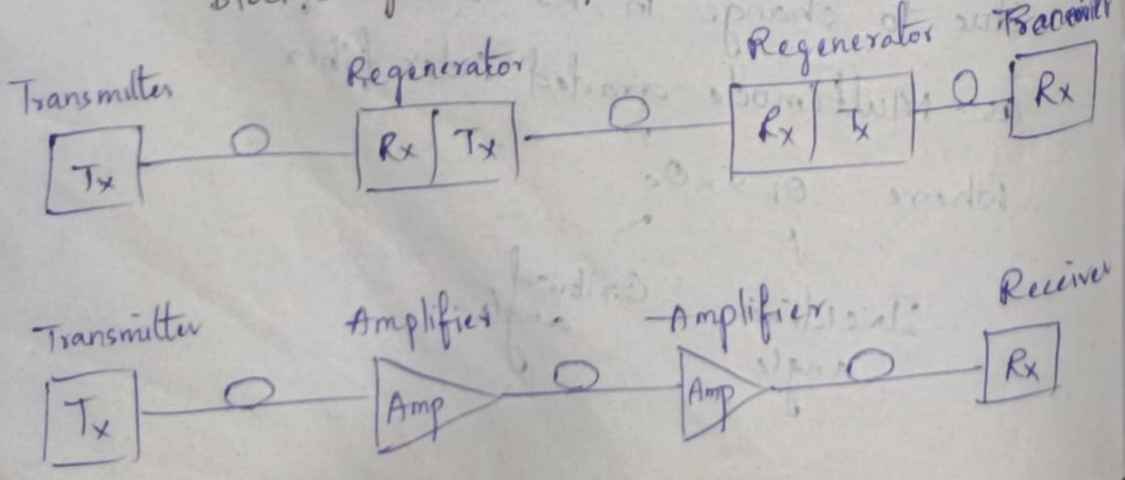


* Block Diagram of Optical fiber Communication:-

If information is transmitting from S to Destinati[on] by means of light or Opticals such a Communication is called as OFC



Block Diagram of optical Communication channel



Working:

- Information source: The device which generates information signal
  ex:- physical voice, text, video

- Electrical transmit: The device which converts i/p physical signal into electrical signal

- Optical source: The device which converts electrical signal into light energy.
  ex:- LED, LASER

- Optical fiber Cable: The path b/w source & destination is called as channel. In OFC, Optical fiber Cable acts as channel
  ex:- step, graded index

- Optical Detector: The device which converts light energy into electrical energy

- Electrical Receiver - The device used for converting electrical signal into energy signal

- Destination: The device which converts i/p signal into physical signal

- Optical channel - In OFC, the channel is made up of optical repeaters used for increasing strength of light rays
- In general, every repealer performs chromatic phenomenon
- The optical repeaters are constructed by using 'Glass' or 'ceramic' material which helps to provide constant chromatic
- In the channel each repeater performs reception & transmission

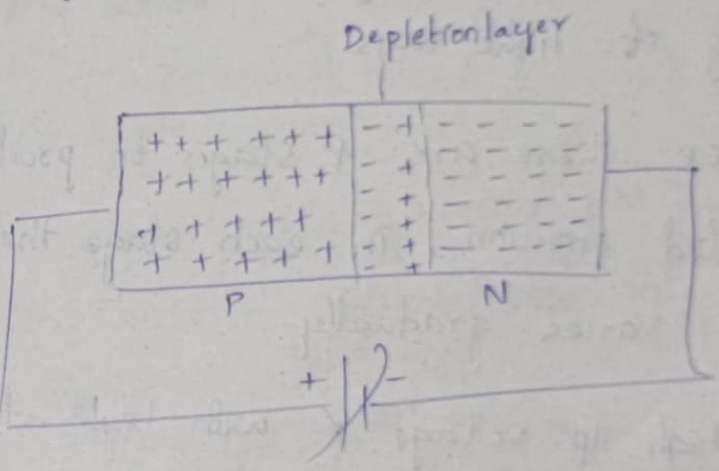
Optical Sources:

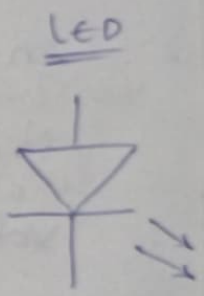
There are 2 types of optical Sources used in OFC namely:

i) LED - Light emitting diode
ii) LASER - Light Amplification by stimulated emission of radiation

i) LED - Light Emitting Diode

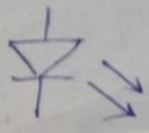
- LED is constructed by using PN Junction Diode
- It operates on the principle of spontaneous emission
- Based upon input voltage it Creates light energy





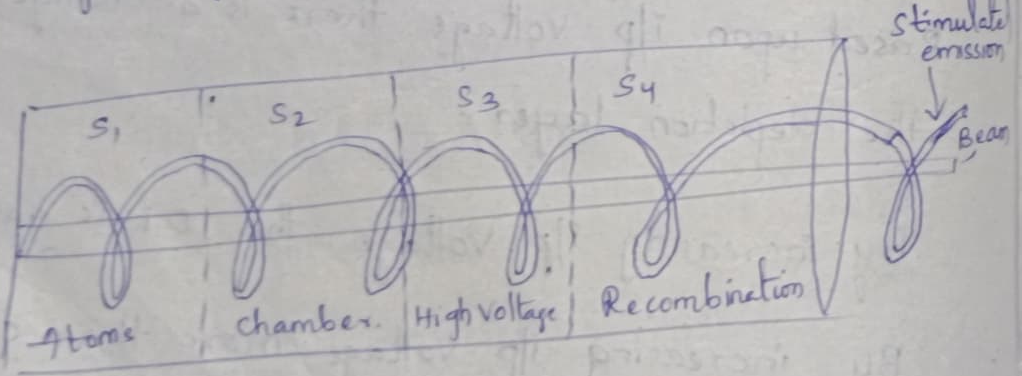
Operation:

- Based upon i/p voltage there is a change in the depletion layer
- By increasing i/p voltage the D.L is Vanished
- By increasing i/p voltage more than 0.7 V there is a flow in the channel from P-N and N-P
- By further increasing the combination of $\bar{e}$ and holes it creates light energy



iii) LASER :- Light Amplification by stimulated emission of radiation.

- Works on the principle of 'stimulated emission'
- LASER creates high intensity of light rays based upon i/p voltage.
- Based upon i/p voltage laser creates high intensity of light rays
- In LASER, there are 4 stages to produce stimulated emission, In each stage the i/p voltage varies gradually
- With high i/p voltage & with high atom recombination LASER generates "high beam light ray".



Optical Receivers

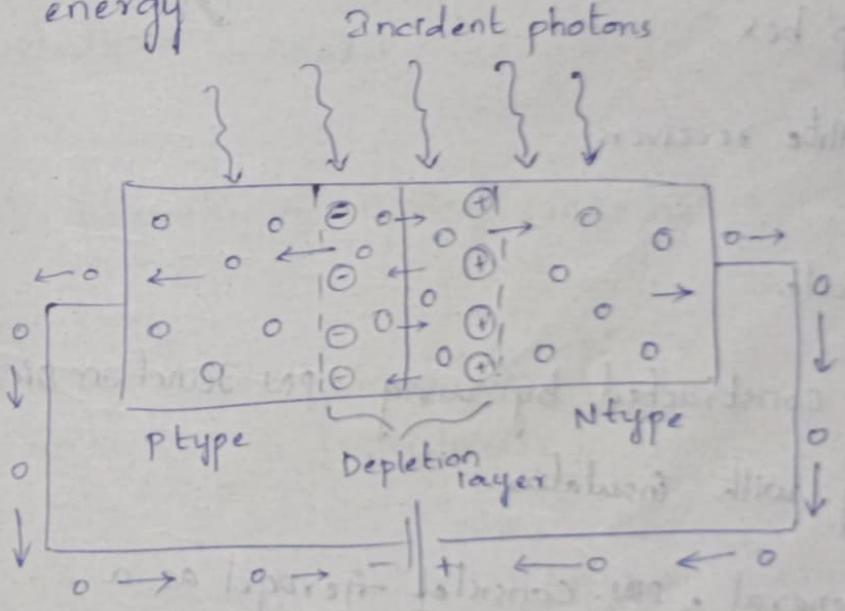
- In OFC, there are several types of optical receivers which converts light energy into electrical energy.

i) Photo Diode

ii) PIN Diode

i) Photo Diode:

- It is constructed by using PN Junction Diode which converts light energy into electrical energy

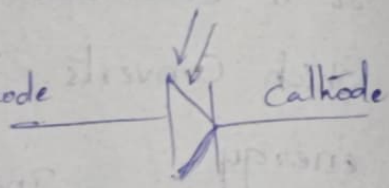


Operation:

- For the i/p light intensity there is a change in the depletion layer
- By increasing light intensity, the potential barrier is vanished
- By the light intensity, it creates flow of $\bar{e}$ in the channel leads to electrical energy

Application:

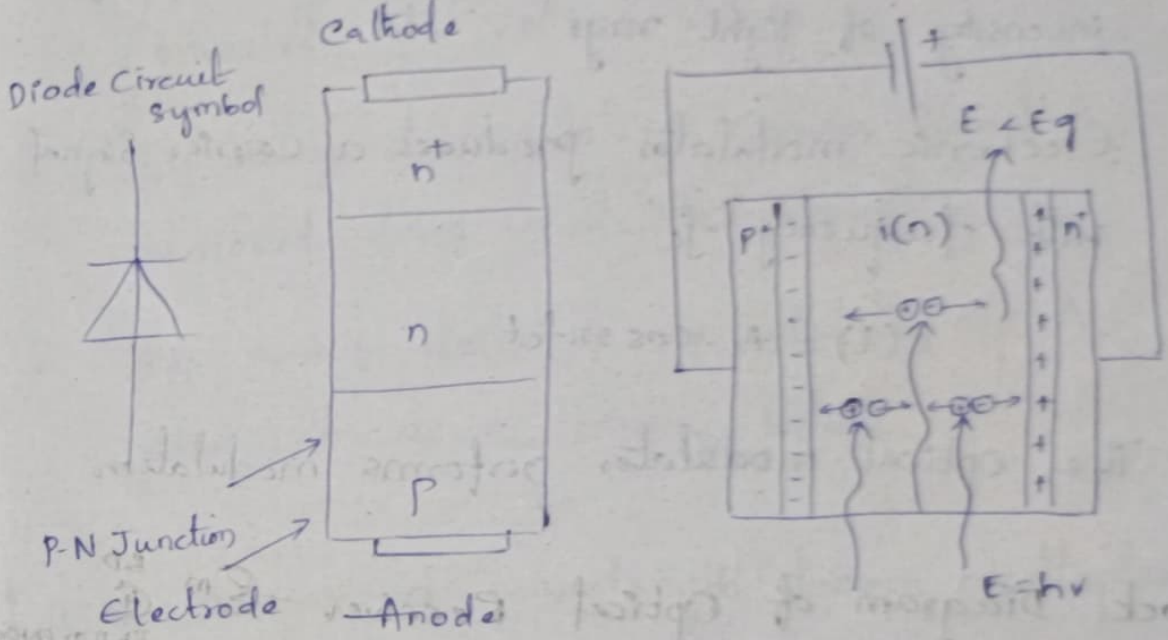
1. Wifi - modules
2. Setup box
3. Satellite receivers



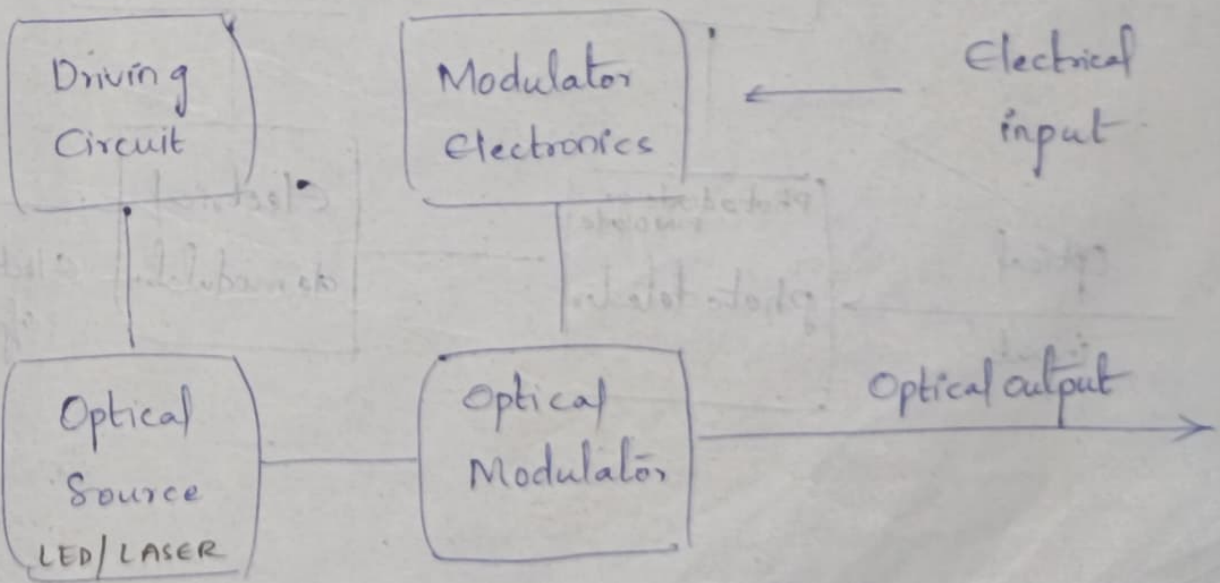
ii) PIN Diode:

- It is constructed by using PN Junction Diode along with insulator
- In General, PIN consists of Aerogel as a insulator which is having property of Conducting for small light intensity

- Based upon input light intensity. Insulator acts as pure conductor which leads to Create electrical energy in the channel



Block diagram of optical transmitter → 5m B.D @ points LED/LASER



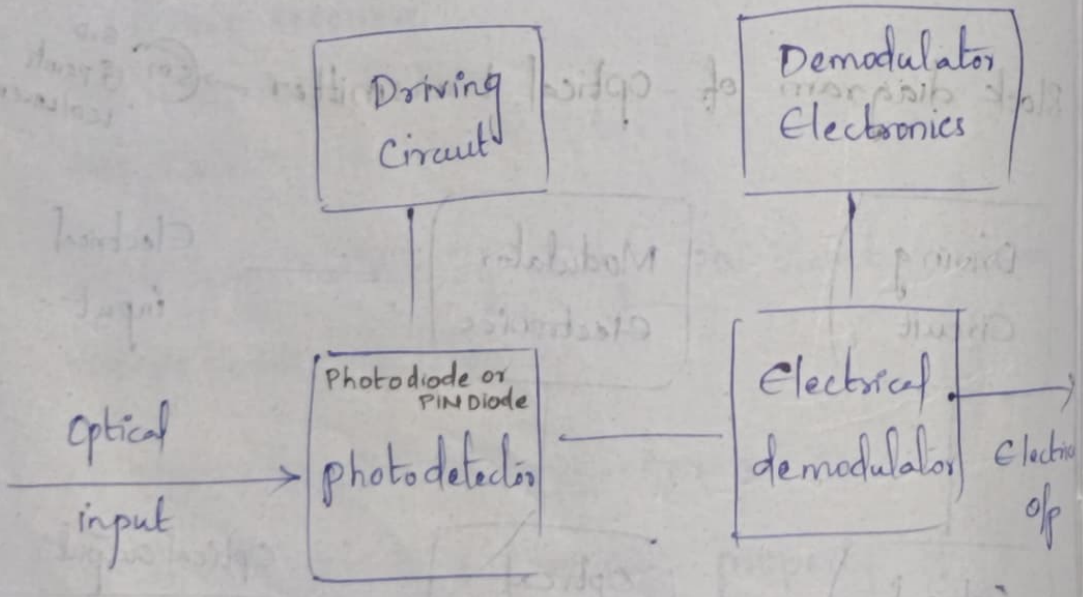
Operation:

- Driving circuit provides i/p voltage to the optical source to generate light energy.
- Optical source like LED or LASER creates high intensity of light rays
- Electronic modulator produces a carrier signal with frequency 'fc'

$$c(t) = A_c \cdot \cos 2\pi f_c t$$

- The optical modulator performs modulation

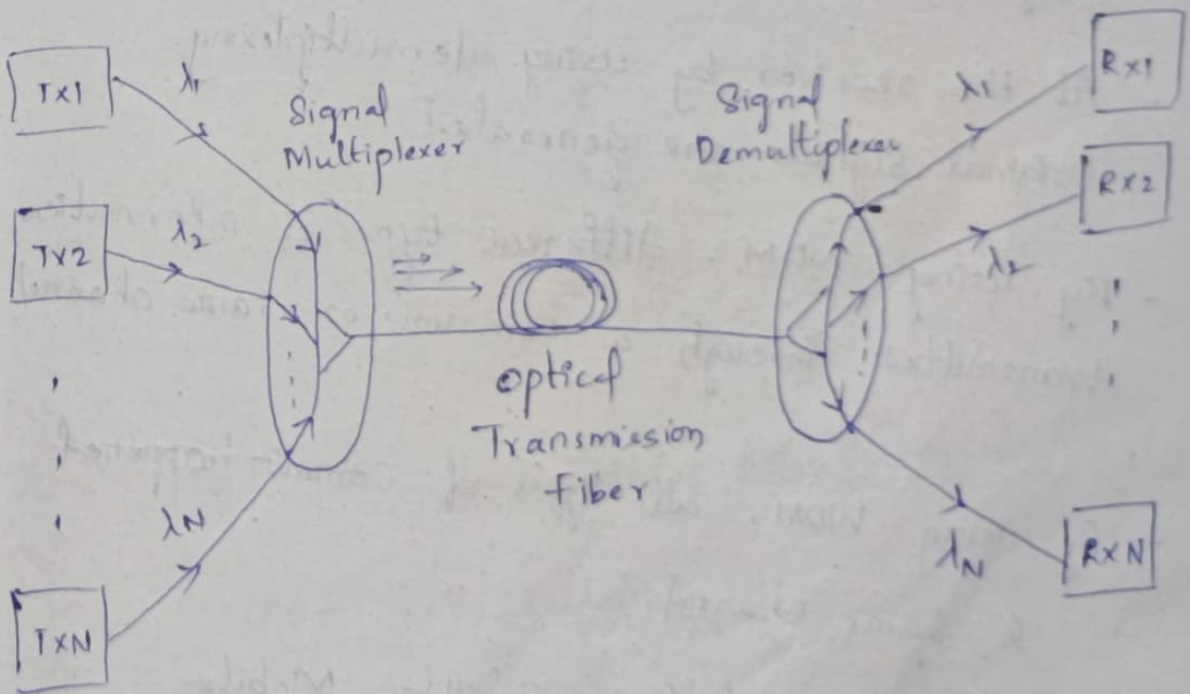
Block Diagram of Optical Receiver



Operation:

- ASK - Digital
- For the i/p light source or light rays photodetector converts light energy into electrical energy
- By using driving circuit electrical energy is converted into voltage values
- By using demodulator, carrier signal is removed from modulated signal
- By using electrical demodulator o/p is produced as a binary values.

* Block Diagram of wavelength division multiplexing



Multiplexing: The process of sending several msg signals through a single channel is called Multiplexing

Whereas in WDM. all inform'n signals transmitted through a single channel by using wavelength division is called as "WDM".

Working:

- For the inform'n signals multiplexer provide unique wavelength in the channel
- In the channel, every signal is seperated by means of its wavelength
- At the receiver by using demultiplexing Original signals are generated
- By using WDM, different types of information transmitted through a common or same channel
- By using WDM, all types of comm'n happened in same channel

ex: optical, telephone, satellite, Mobile

UNIT-5

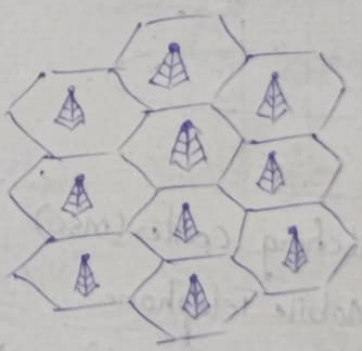
Cellular and Mobile Communications

Cellular Mobile Communication:

- If communication happens by using cellular and mobile phone
- In General all CMC's uses or cellsite as a channel

Cellsite:

- It is defined as cell tower & Coverage area
- All cellsites are in the shape of Hexagonal.



** Limitations of conventional Mobile Telephone Systems

1. Limited service capability
2. Poor service performance
3. Inefficient frequency spectrum utilization

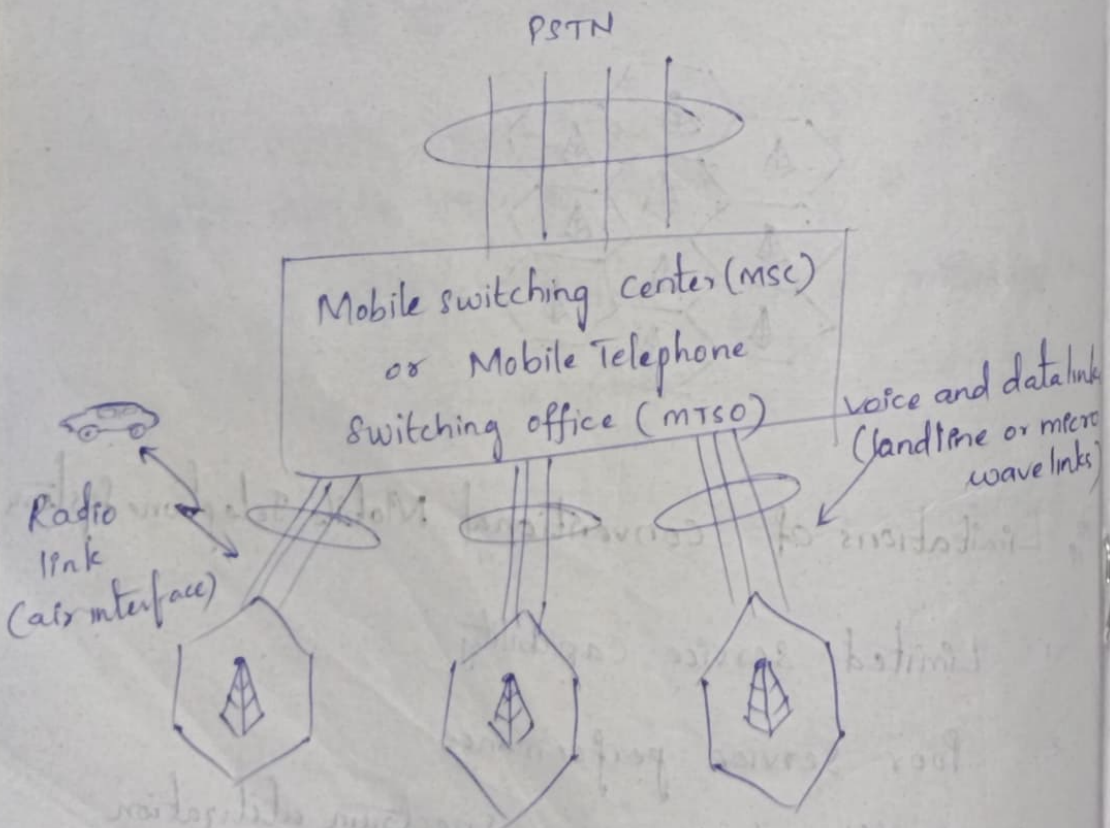
i) In Mobile telephone system each cellsite allocated with a predefined frequency values due to this the limitations are happened

ii) In the cellsite due to increasing of no of users service capability is reduces which leads to poor service

iii) In the cellsite due to predefined frequency values utilization of frequency is inefficient

overcome (3) limitations

Basic cellular Telephone / Mobile system



Working:

- Cellsite: Cellsite is a combin of tower & coverage area which is having 'n' no of frequency values to connect all mobiles in the area.

- Mobile unit: It contains SIM and mobile equipment to send information or receive information

- MTSO: It is the heart of the cellular system which provides connection to various cellsites

- Connections: There are 2 types of connections or links namely i) Voice links
  ii) Data links

  i) Voice links: Used for transmitting voice informin
  ii) Data links: Used for transmitting data signals
  ex:- Texts, MMS

- PSTN: Public switching Telephone N/w
  PSTN is used for transmitting data from mobile to telephone.

Comparison of 1G, 2G, 3G, 4G, 5G

Frequencies

1G - 2.4 kb/s - voice, also called as AMPS

2G - 64 kb/s - Voice, Msg

3G - 2 Mb/s - Voice, Msg, Internet access, text, Vc

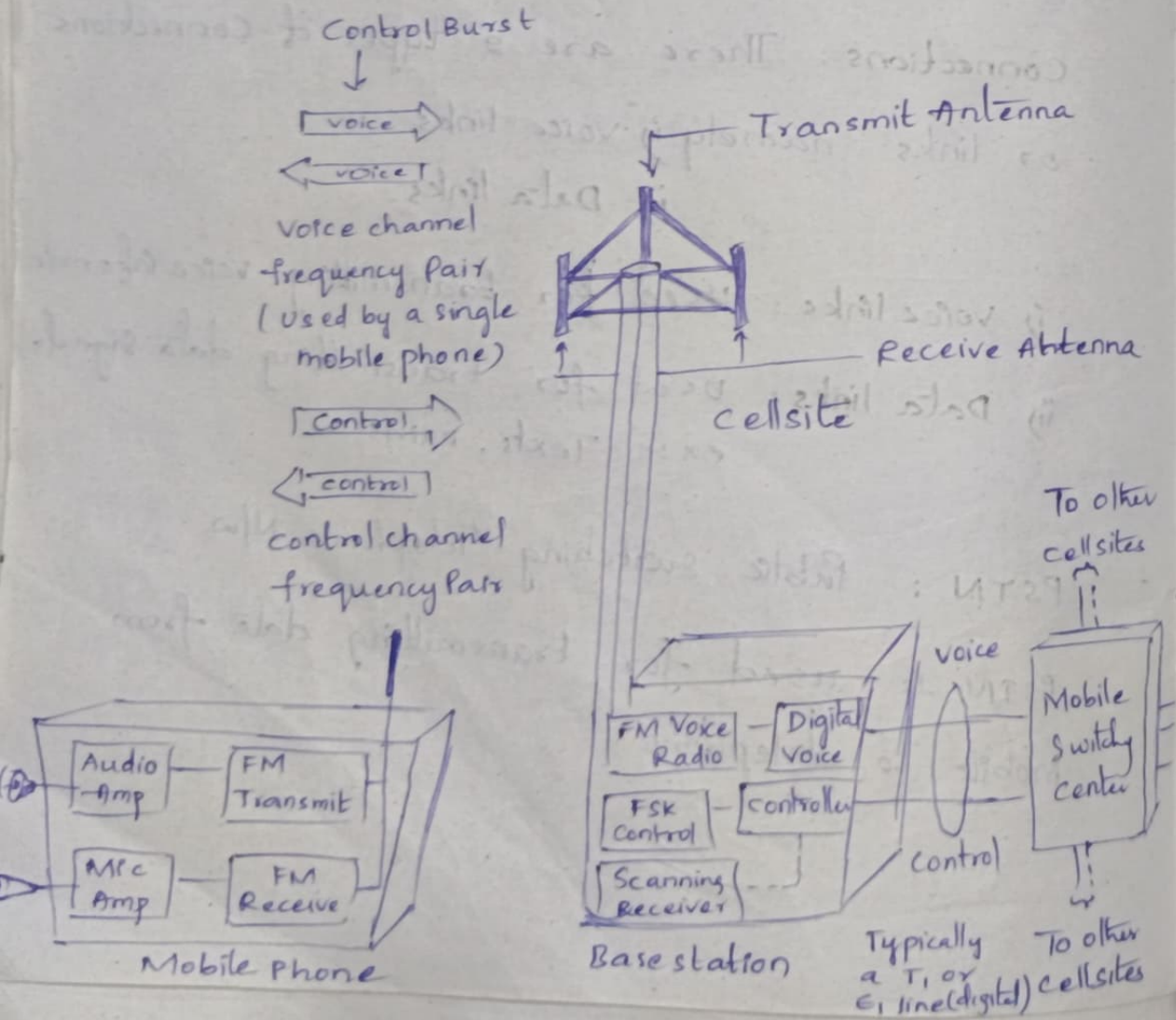
100 - Mb/s - voice, msg, Text, Internet acess, Vc-4k

5G - More than 1Gb/s - Voice, msg, Text, Internet access, Video-4k

AR - Augmented reality

VR - Virtual reality

AMPS (Advanced Mobile Phone Service)



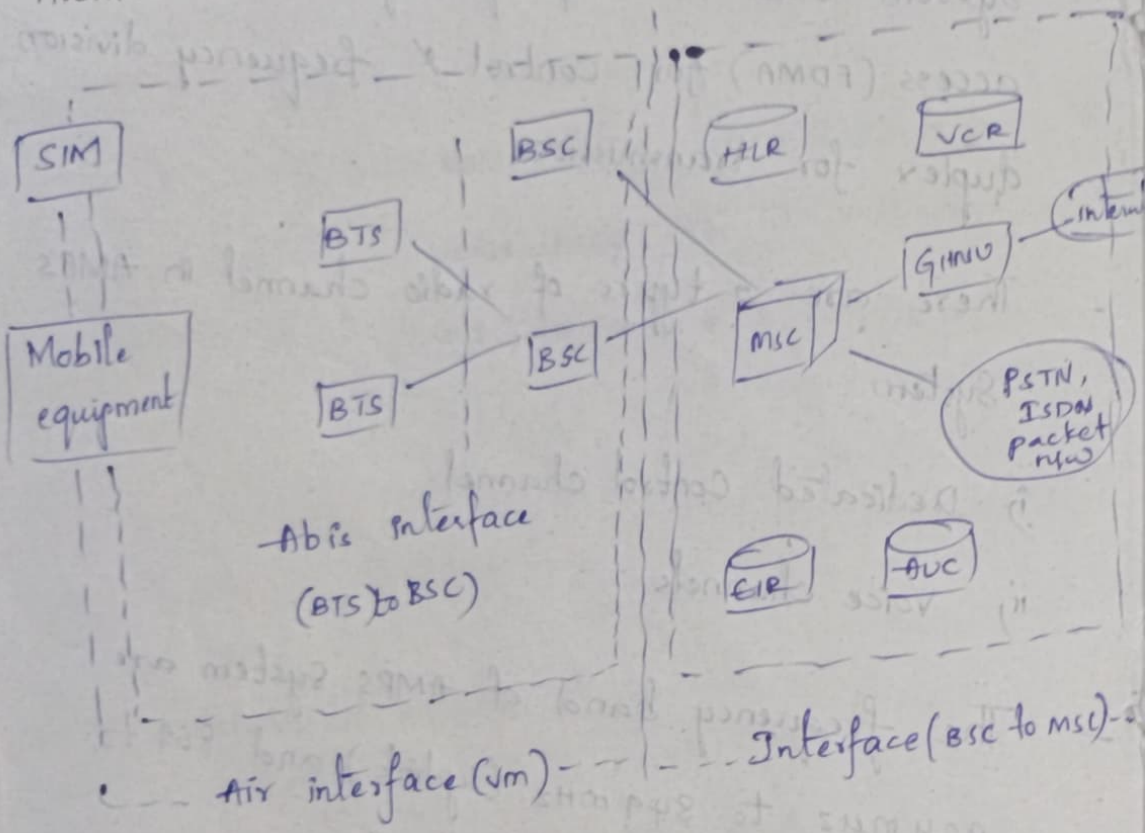
Operation of AMPS:

- AMPS is an analog cellular communication system that uses frequency division multiple access (FDMA) for control & frequency division duplex for transmission.
- There are 2 types of radio channel in AMPS System
  i) Dedicated control channel
  ii) Voice channels
- The frequency band of AMPS system are 824 MHz to 849 MHz (uplink) and 869 to 894 MHz (downlink)
- The control channel continuously sends system identification information & access control information
- The control channel and voice channel signals are transferred at 10kbps

To public switched Telephone network

Global system for mobile communication (GSM):

Architecture:



SIM: Subscriber Identity module

ME: Mobile equipment

BTS: Base transreceiver station

BSC: Base station Controller

HLR: Home location register

VLR: Visitor location register

EIR: Equipment identity register

AUC: Authentication center

MSC: Mobile Service Switching center

* Global System for mobile Communication (GSM):

- The Global System for mobile communication (GSM) is a global digital radio system that uses time division multiple access (TDMA) technology
- GSM is a digital cellular technology that was initially created to provide a single standard Pan-european Cellular System.
- GSM technology has evolved to be used in variety of systems & frequencies (900mHz, 800mHz and 1900 mHz)
- The GSM Cellular System allows 8 mobile telephones to share a single 200 kHz bandwidth radio carrier waveform for voice or data communication

CDMA:

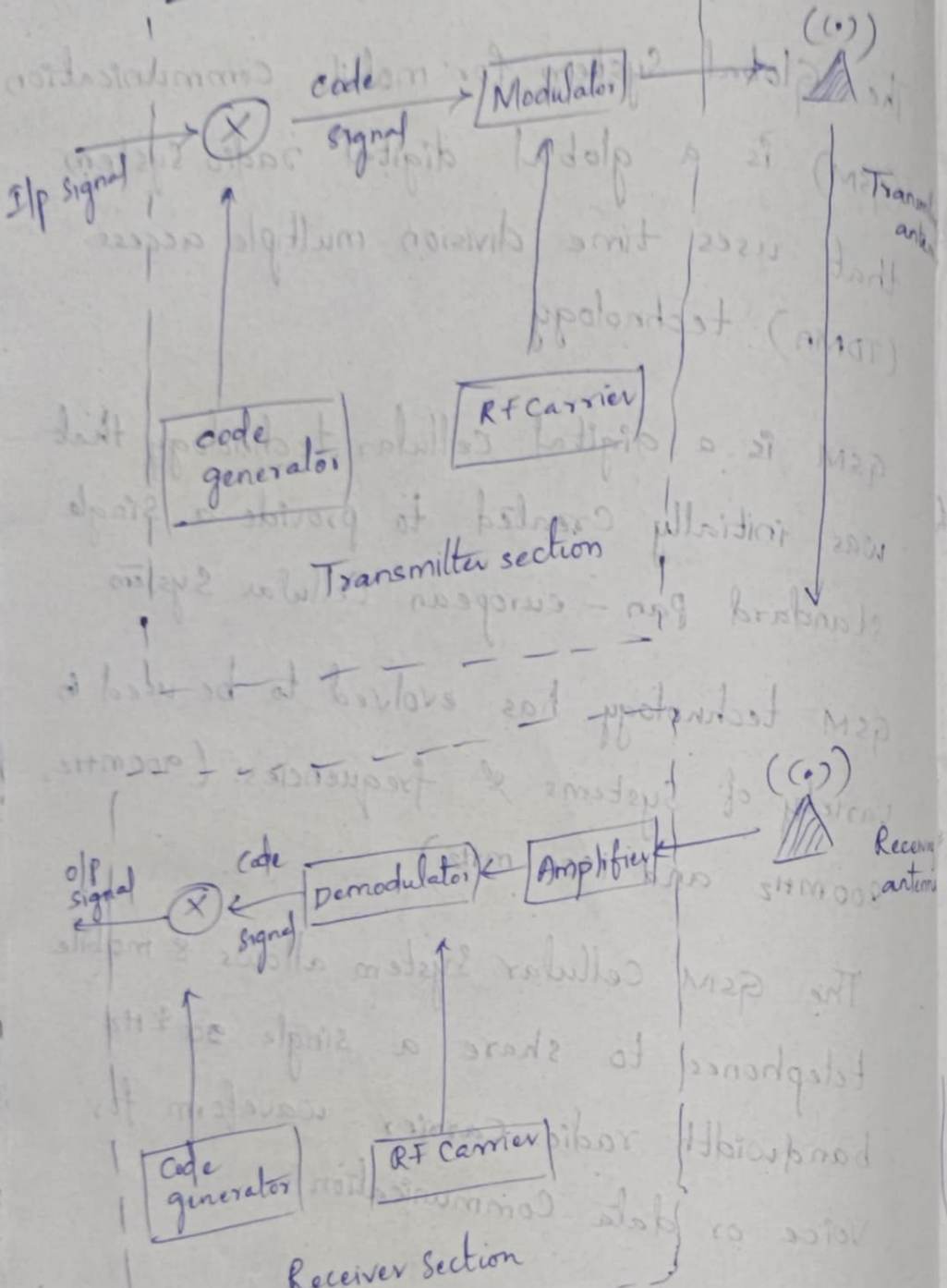
- In CDMA every user sends / receives information based upon codes
- Each code is generated from Spectrum
- The modulation & demodulation is purely based upon parameters of carrier signal

Globa

Arch

SIM

Mobile equipm



SIM

ME

BTS

BSC

HLR:

VLR:

EIR:

AUC:

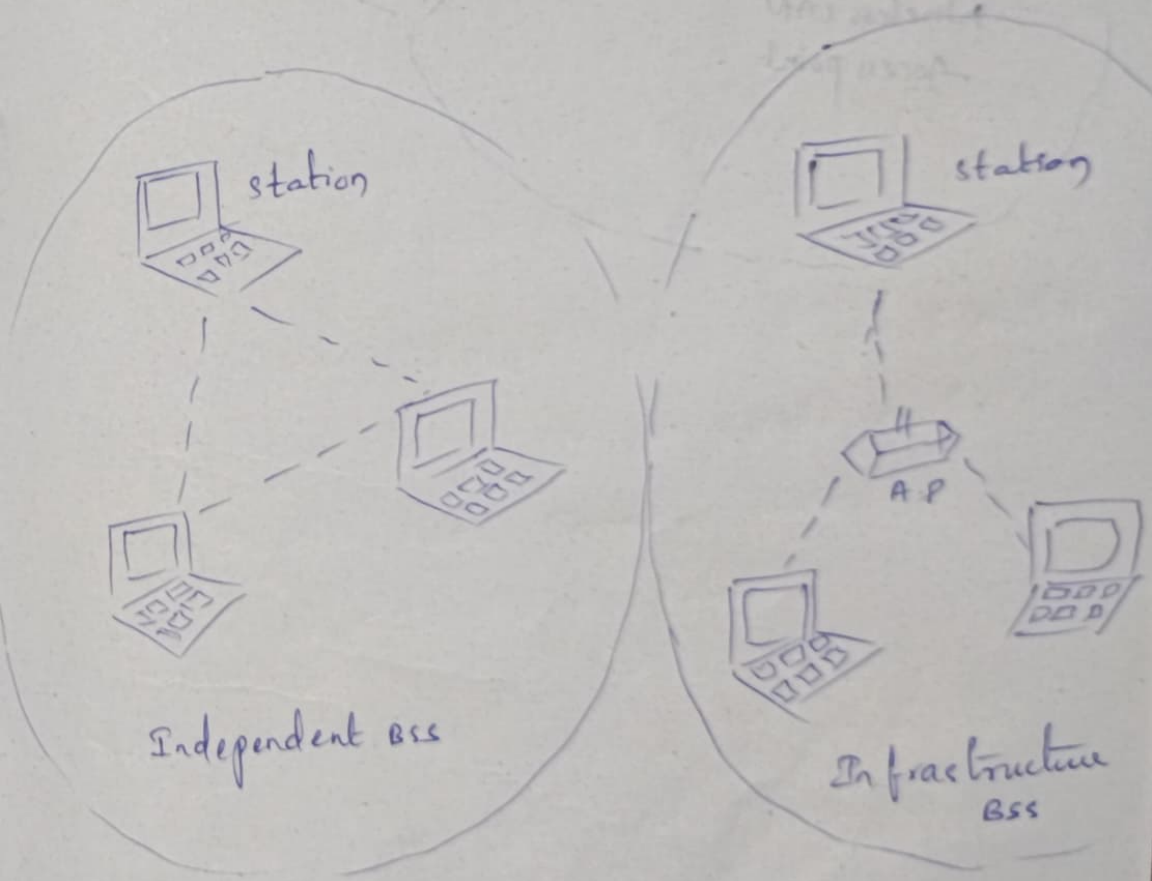
MSC

Block Diagram of DS - CDMA

Wireless LAN (WLAN - IEEE 802.11)

IEEE 802.11 network consists of four major components:

i) Station
ii) Access ponts
iii) Wireless medium
iv) Distribution System



Wireless personal area network (WAN - IEEE 802.15)