CT-1

1. Data Communication:

Data Communications are the exchange of data between two devices via some form of transmission medium such as a wire cable or in wireless form.

- Five components of data communication:

1. Message: The message is the information to be communicated between sender and receiver. Ex: text, number, picture, ~~ad~~ audio, video.

2. Sender: The sender is the device that sends the data message. Ex: Workstation, telephone handset, video camera.

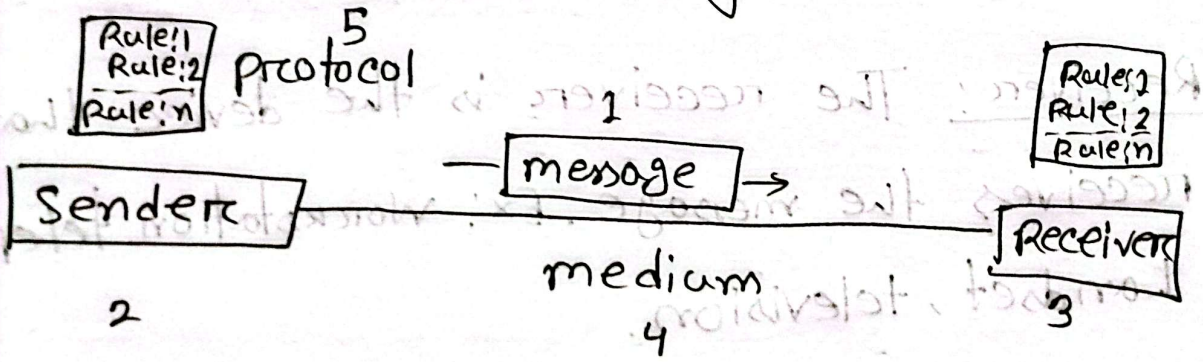
3. Receiver: The receiver is the device that receives the message. Ex: workstation, telephone handset, television.

CS CamScanner

4. <u>Transmission medium:</u> The transmission medium is the physical path by which a message travels from sender to receiver.

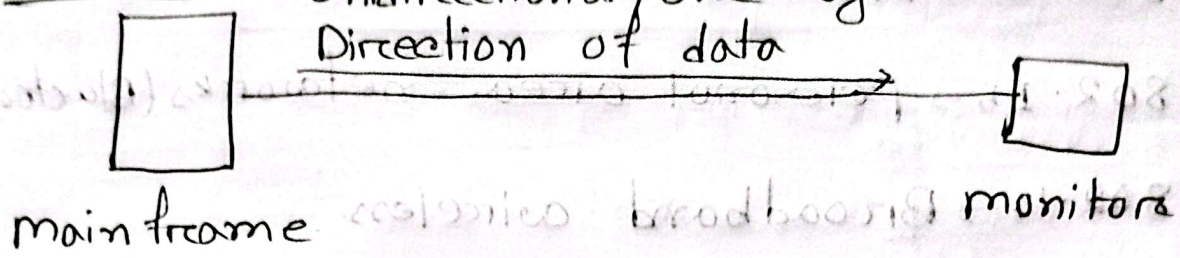
Ex: Twisted-pair ~~cable~~wire, coaxial cable, fiber-optic cable, radio waves.

5. <u>Protocol:</u> A protocol is a set of rules that govern data communications. It represents an ~~aggre~~ agreement between the communicating devices. Without a protocol, two devices may be connected but not communicating.

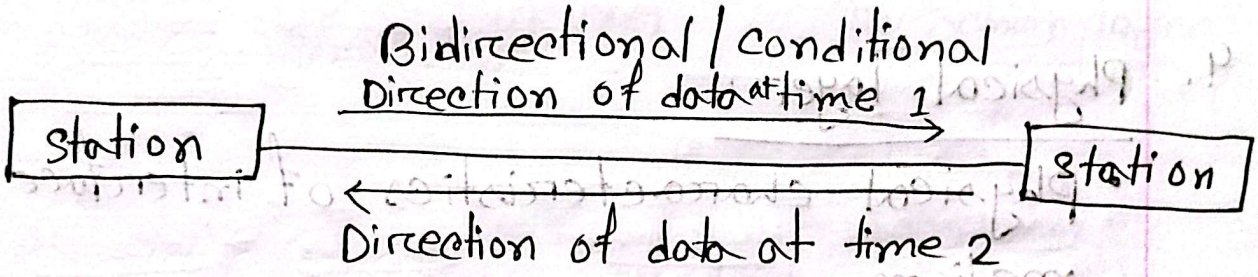


2. Simplex, Half-duplex, Full-duplex:

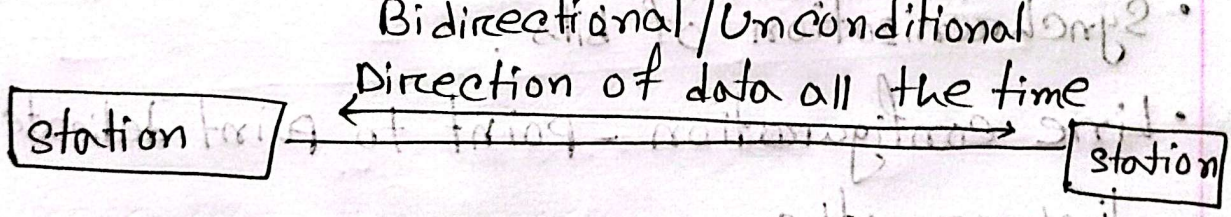
a. Simplex:



b. Half-duplex:



c. Full-duplex:



Example:

Simplex: keyboards and traditional monitors, television

Half-duplex: walkie-talkie and fax radio.

Full duplex: Telephone / mobile network.

CamScanner

3. IEEE standard names:

802.3 → Ethernet

802.15 → personal area networks (Bluetooth)

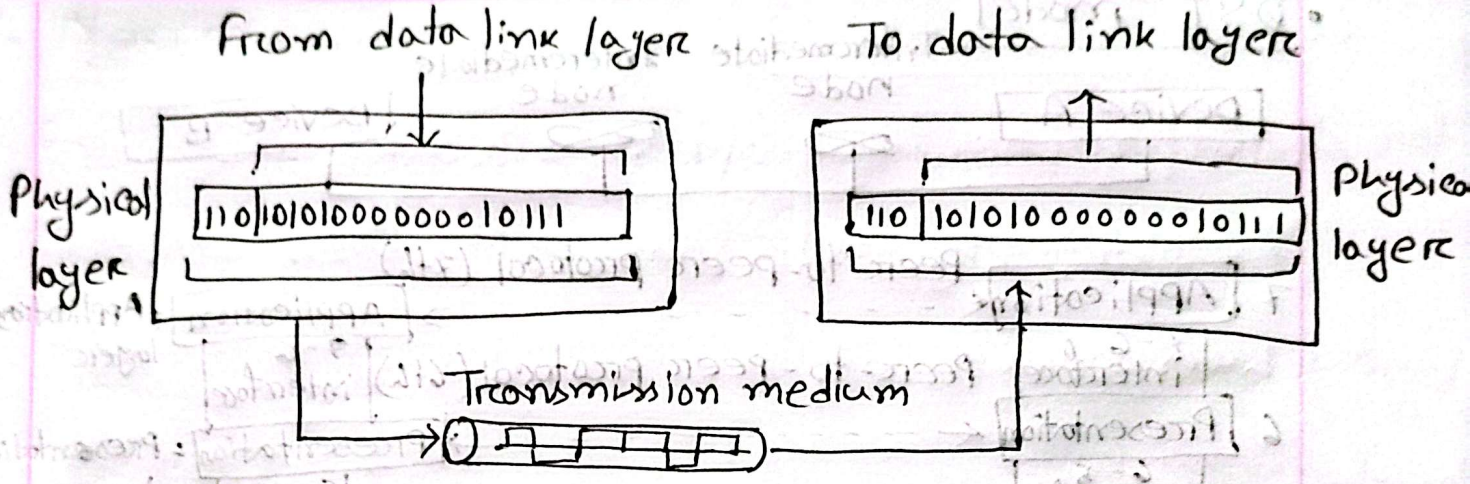
802.16 → Broadband wireless

Extra!

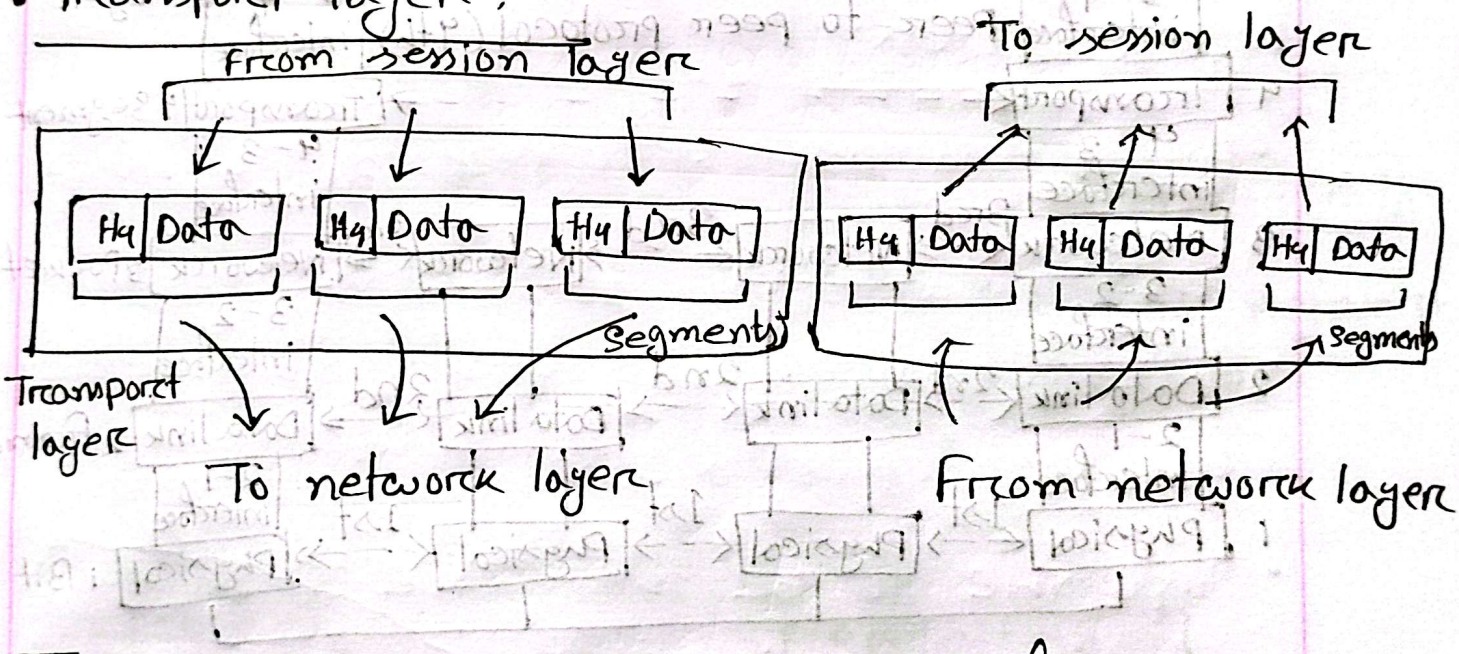
802.11 → Wireless LANs

4. Physical layer:

- Physical characteristics of interface and medium.
- Representation of bits.
- Data Rate,
- Synchronization of bits.
- Line configuration - point to point dedicated link or others.
- Physicl topology - Star/mesh/ring.
- Transmission mode - Simplex / half duplex / full duplex.

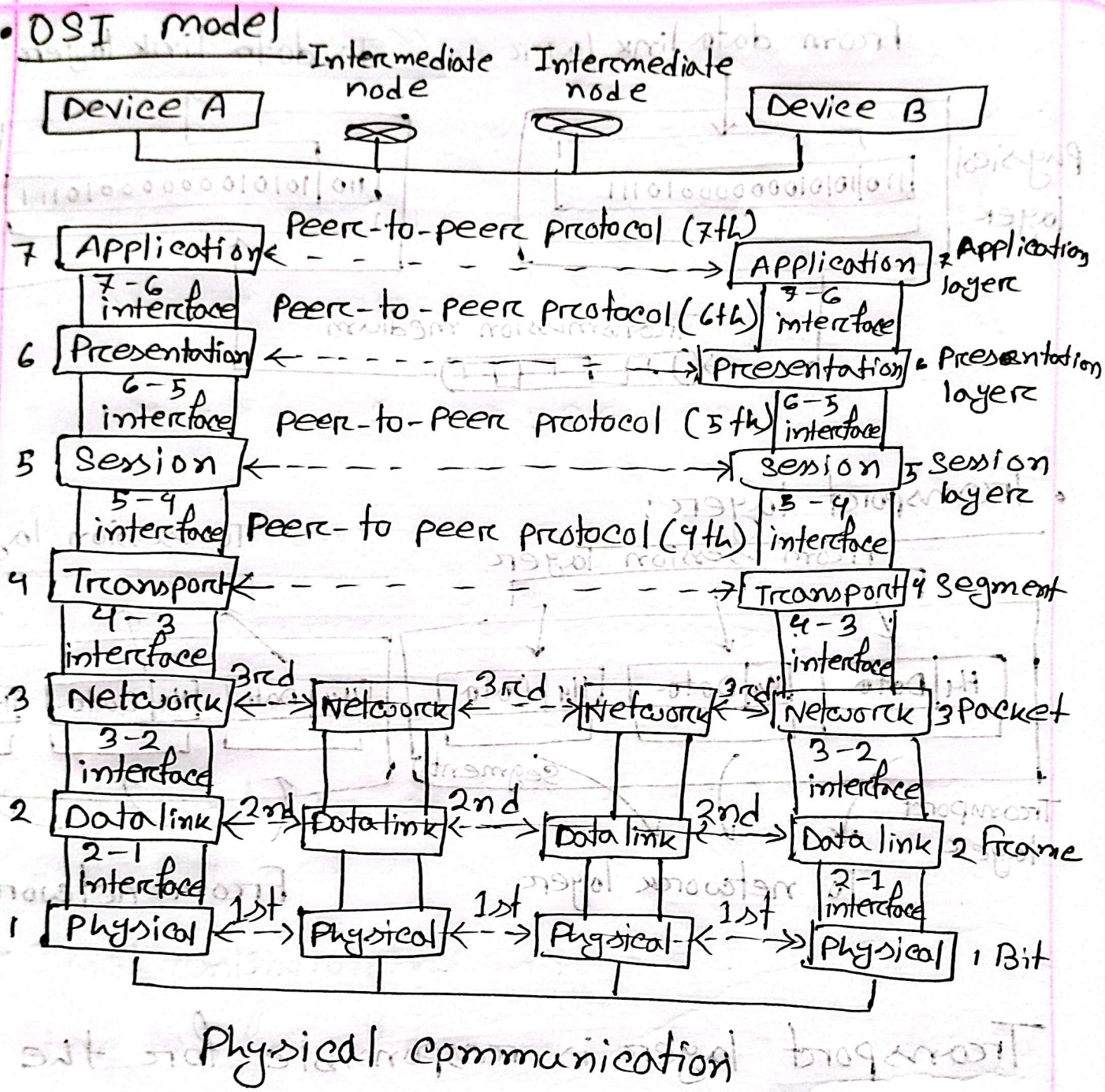


- Transport layer:



Transport layer is responsible for the delivery of a message from one process to another.

- OSI model

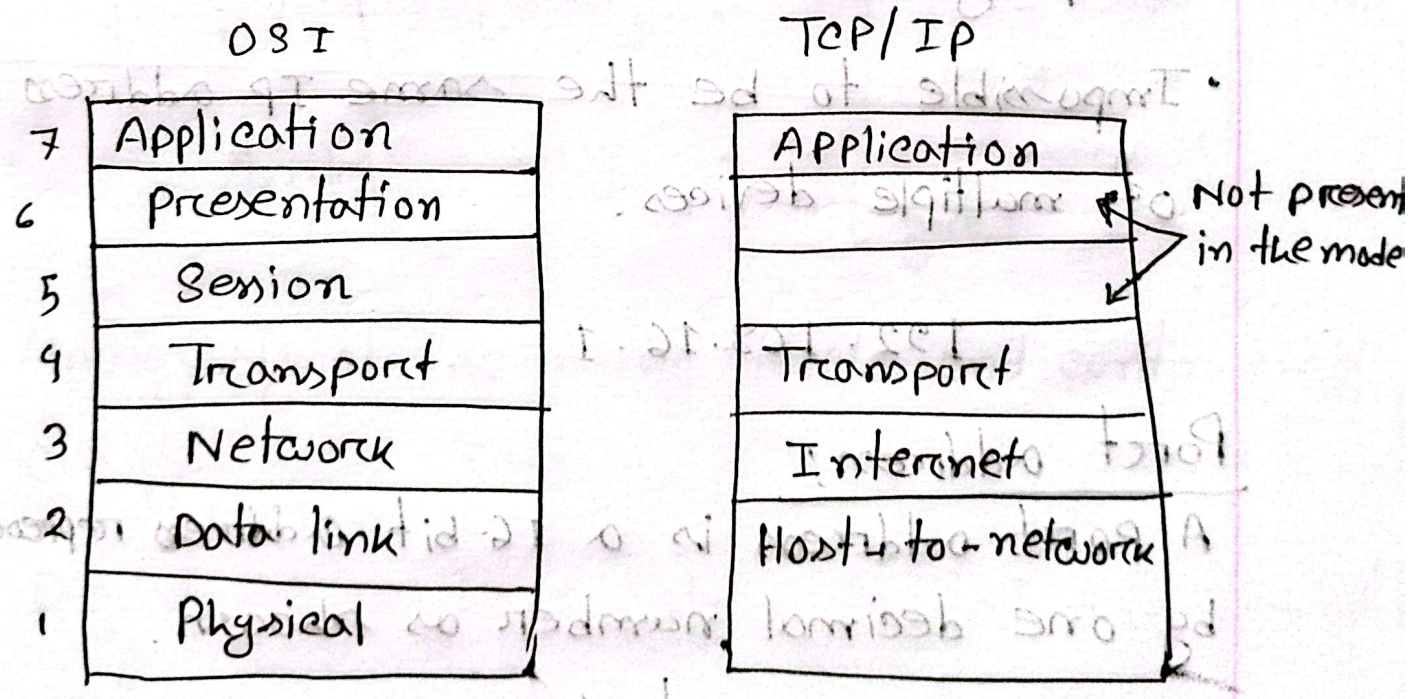

Intermediate node
Intermediate node
Device A
Device B
Peer-to-peer protocol (7th)
7 Application
Application
7 Application layer
7-6 interface
Peer-to-peer protocol (6th)
6 Presentation
Presentation
6 Presentation layer
6-5 interface
peer-to-peer protocol (5th)
5 Session
Session
5 Session layer
5-4 interface
Peer-to peer protocol (4th)
4 Transport
Transport
4 Segment
4-3 interface
3rd
3 Network
Network
Network
Network
3 Packet
3-2 interface
2nd
2 Data link
Data link
Data link
Data link
2 Frame
2-1 Interface
1st
1 Physical
Physical
Physical
Physical
1 Bit
Physical communication

5. Yes, I agree.

The layers in the TCP/IP protocol suite do not exactly match those in the OSI model.

The original TCP/IP protocol suite was defined as having four layers: host-to-network, internet, transport and application.

However, when TCP/IP is compared to OSI, we can say that the TCP/IP protocol suite is made of five layers: physical, data link, network, transport and application.



6. Physical address:

The most local-area networks use a 48-bit (6-byte) physical address written as 12 hexadecimal digits.

07:01:02:01:2C:4B

Logical address:

- Logical address are necessary for universal communication.
- A logical address is a 32-bit address that uniquely define a host.
- Impossible to be the same IP address of multiple devices.

192.168.16.1

Port address:

A port address is a 16-bit address represented by one decimal number as shown.

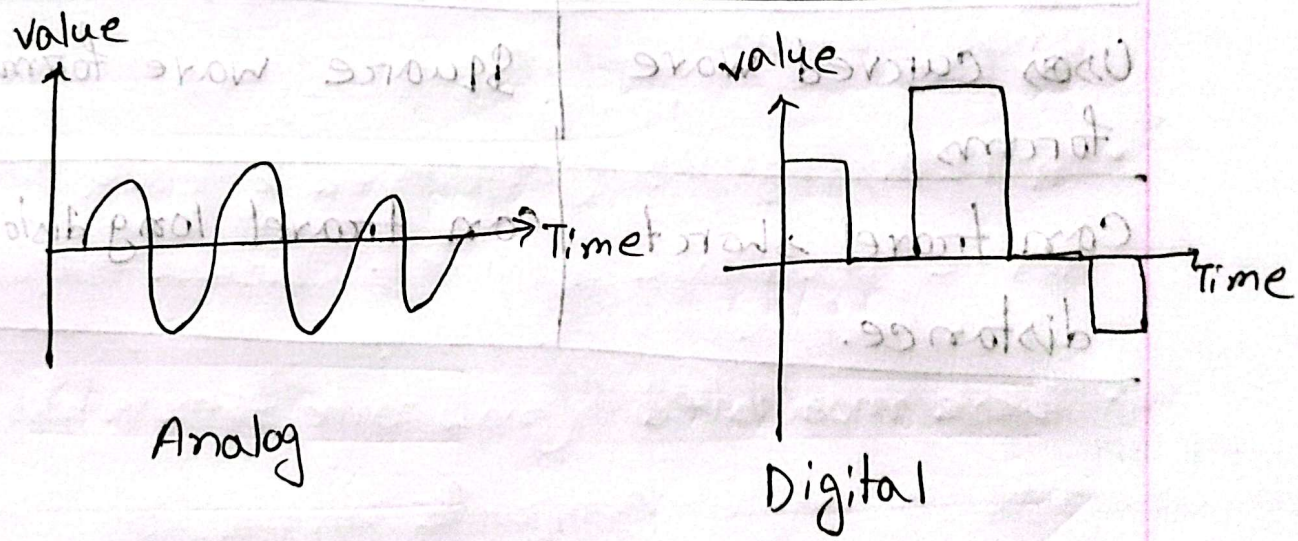
753-tcp/udp.

CT-2

1. **Data:** Data is a collection of information that can be processed, analyzed and used for reasoning, discussion or decision-making.

Signal: A signal is anything that conveys information often through a physical phenomenon that varies over time or space.

- **Comparison analog and digital signal:**

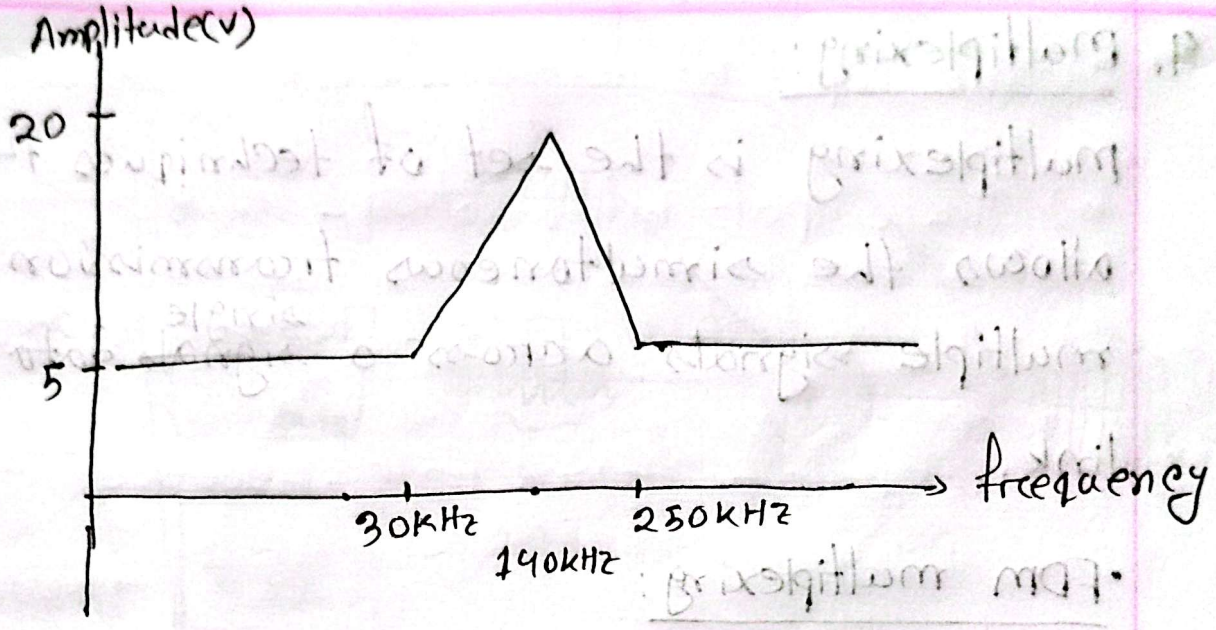


- Analog signals has many levels and continuously change over time.
- Digital signals have only a limited number of define values often 0 and 1.

Analog	Digital
Used to transmit video and audio signals.	Used to transfer (0,1) bits generally for file transfer.
Used when we don't have large bandwidth	Used when we have large bandwidth.
Higher error rate	Low error rate
Continuous by nature.	Discrete by nature.
Uses curved wave forms	Square wave forms.
Can travel short distance.	Can travel long distance.

CamScanner

2.



3. $C = B\log_2(1 + SNR) = 3000\log_2(1 + 3162)$

$= 3000\log_2 3163$

$= 3000 \times 11.62$

$= 34,860$ bps.

4. <u>Multiplexing:</u>

multiplexing is the set of techniques that allows the simultaneous transmission of multiple signals across a ~~signals~~ single data link.

- <u>FDM multiplexing:</u>

- Frequency-division multiplexing is an analog multiplexing technique that combines analog signals.

- In FDM, signals generated by each sending device modulate different carrier frequencies.

- These modulated signals are then combined into a single composite signal that can be transported by link.

CamScanner

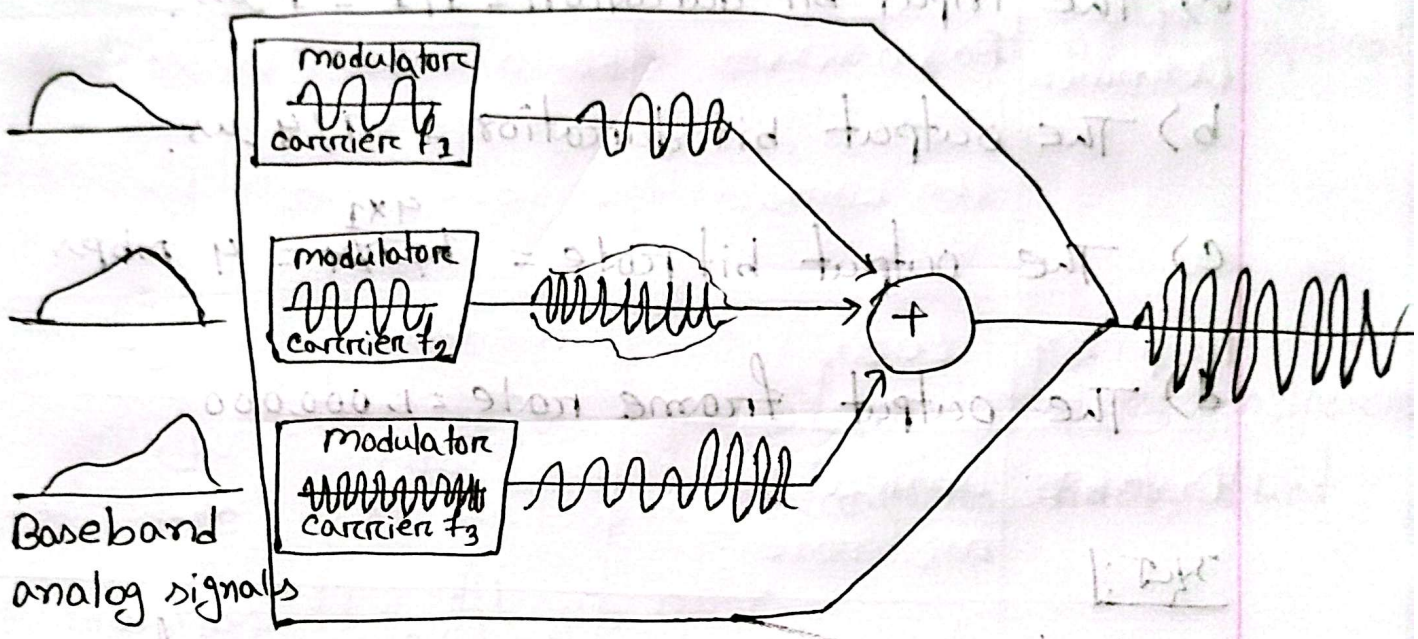


Fig: FDM multiplexing.

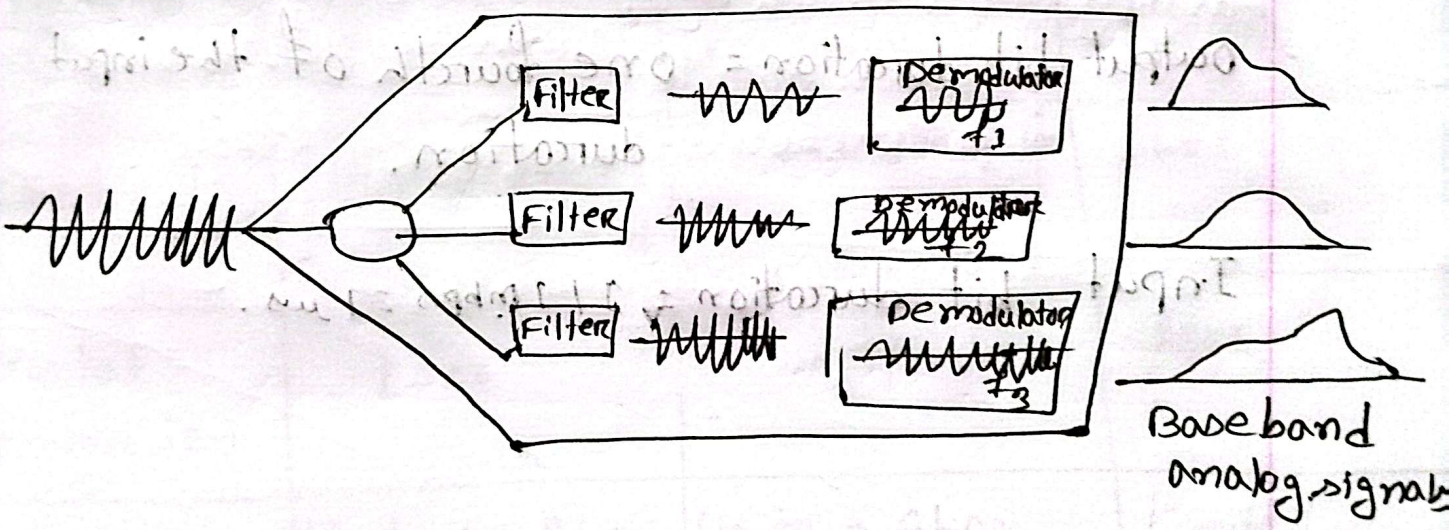


Fig: FDM demultiplexing.

5. a) The input bit duration = 1/1 = 1 μs.

b) The output bit duration = 1/4 μs.

c) The output bit rate = $\frac{4 \times 1}{1/4}$ = 4 mbps

d) The output frame rate = 1,000,000

উত্তর:

Output bit rate = sample size × num. of sample per second × num. of channels.

output bit duration = one-fourth of the input duration.

Input bit duration = 1 / 1 mbps = 1 μs.

CT-3

1. **Core:**

The core refers to the central part of the optical fiber, typically made of glass or plastic.

Cladding:

Cladding refers to a layer of material with a lower refractive with a lower refractive index that surrounds the fiber's core.

Feature	50/125 μm	62.5/125 μm	100/125 μm
Core size	Smaller	medium.	Larger
Bandwidth	High (~500+ MHz-km)	~160-200 MHz-km	Low
modal Dispersion	Low	moderate	High
max Data Rate	Up to 10 Gbps and beyond	Up to 1 Gbps	Limited
Distance	Long	medium	short
Light coupling	Harder	Easier	very Easy
Standards	OM2/OM3/OM4/OM5	OM1	Legacy/Obsolete

Propagation

2.

Features	Ground	Sky	Line of Sight
Definition	Radio waves travel close to the Earth's surface	Radio waves reflected by the ionosphere.	Direct straight line path between transmitter and receiver.
Frequency	Low	medium	High
Distance	Limited to moderate	very long	Short to moderate
Application	Am radio broadcasting	HF radio	TV, FM radio
Advantages	can reach beyond horizon due to diffraction	Enables global communication without satellites	Low delay, High bandwidth, Clear reception

3. Packet vs. circuit switches :

- Data packets (in packet switched networks) have headers and samples (in circuit switched networks) don't have headers.

Circuit switching technique is more suitable for each type of communication. Because -

- A circuit-switched network consists of a set of switches connected by physical links, in which each link is divided into n channels using FDM to TDM.

- A connection between to stations is a dedicated path made of one or more links. However, each connection uses only one dedicated channel on each link.

CS CamScanner

4. Given,

Switch 1 delay = 3 ms, switch 2 = 10 ms,

switch 3 " = 20 ms, " 4 = 7 ms

" 5 " = 20 ms

Propagation speed = 2×10^8 m/s = 2×10^5 km/s

We know,

$$\text{Propagation delay} = \frac{\text{Distance}}{\text{propagation speed}}$$

Total delay = switch delay + propagation delay.

For diagram 1,

Distance = 3200 km

Switch delay = (3+20+20) ms = 43 ms

$$\text{propagation delay} = \frac{3200}{2 \times 10^5} = 0.016 \text{ s} = 16 \text{ ms}$$

Total delay = (43 + 16) = $\boxed{59 \text{ ms}}$

For diagram 2,

Distance = 11700 km

Switch delay = (3+10+20) = 33 ms

$$\text{Propagation delay} = \frac{11700}{2 \times 10^5} = 0.0585 \text{ s} = 58.5 \text{ ms}$$

Total delay = (33 + 58.5) = $\boxed{91.5 \text{ ms.}}$

For diagram 3,

Distance = 12200 km

Switch delay = (3+10+20+20) = 53 ms

Propagation delay $= \frac{12200}{2\times10^5} = 0.061\ s = 61\ ms$

Total delay $= (53+61) = \boxed{114\ ms.}$

For diagram 4,

Distance = 10200 km

Switch delay $= (3+7+20) = 30\ ms$

propagation delay $= \frac{10200}{2\times10^5} = 0.051\ s = 51\ ms$

Total delay $= (51+30) = \boxed{81\ ms}$

For datagram 5,

Distance = 10700 km

Switch delay $= (3+7+20+20) = 50\ ms.$

Propagation delay $= \frac{10700}{2\times10^5} = 0.0535\ s$

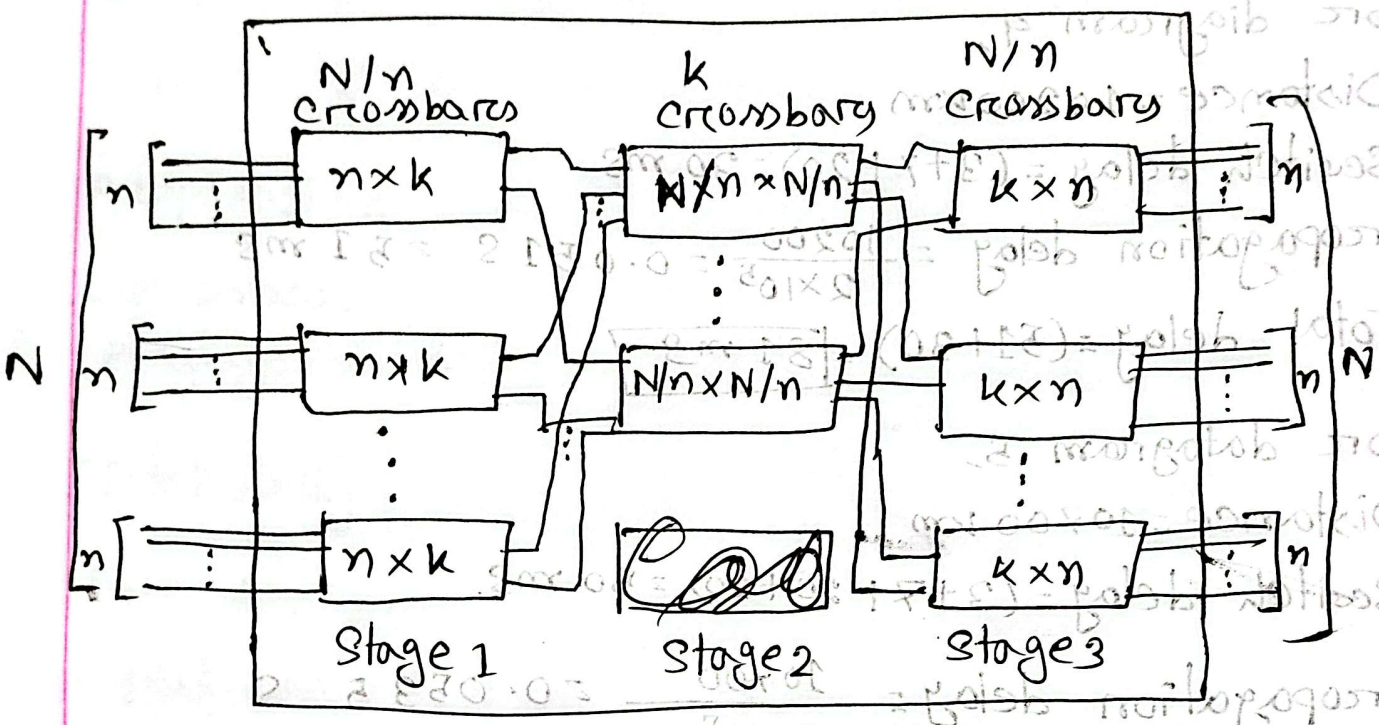
$= 53.5\ ms$

Total delay $= (53.5+50)\ ms = \boxed{103.5\ ms}$

The order in which the datagrams will arrive:

$1 \rightarrow 4 \rightarrow 2 \rightarrow 5 \rightarrow 3.$

5. Multistage switch:



Total crosspoints can be calculated as;

$$\frac{N}{n}(n \times k) + k\left(\frac{N}{n} \times \frac{N}{n}\right) + \frac{N}{n}(k \times n)$$

CT-4

1. Line coding:

Line coding is the process of converting digital data to digital signals.

- DC components:

When the voltage level in a digital signal is constant for a while, the spectrum creates very low frequencies. These frequencies are around zero, called DC components.

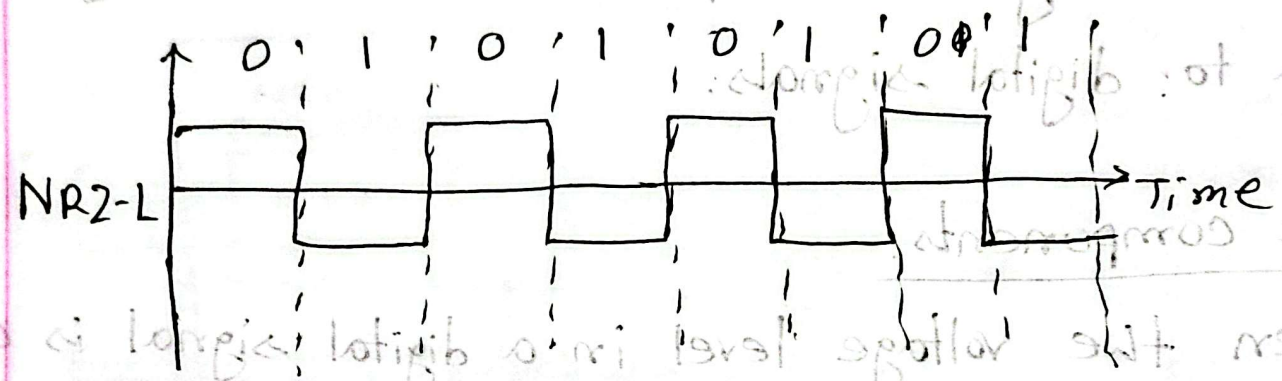
- Synchronization problem:

The synchronization problem refers to the challenge of ensuring that transmitted signals are properly aligned in time and phase at the receiver, allowing for accurate decoding and interpretation.

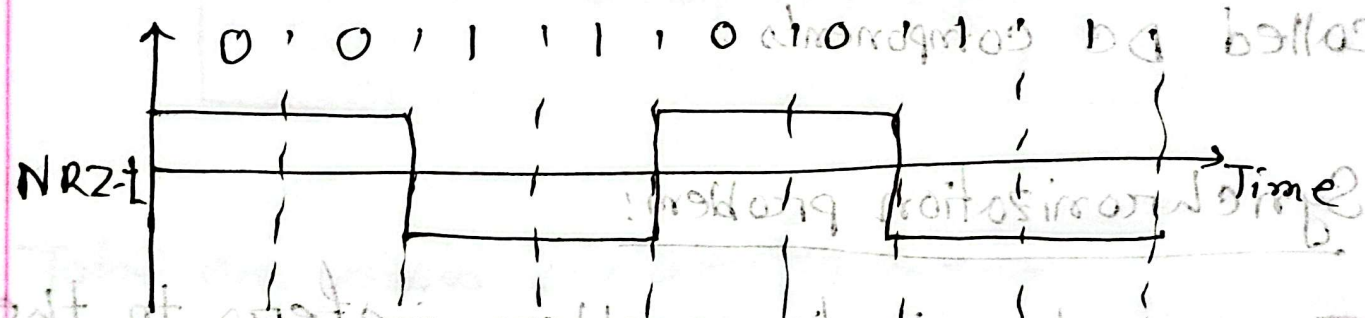
CamScanner

2. NRZ-L:

1. 01010101

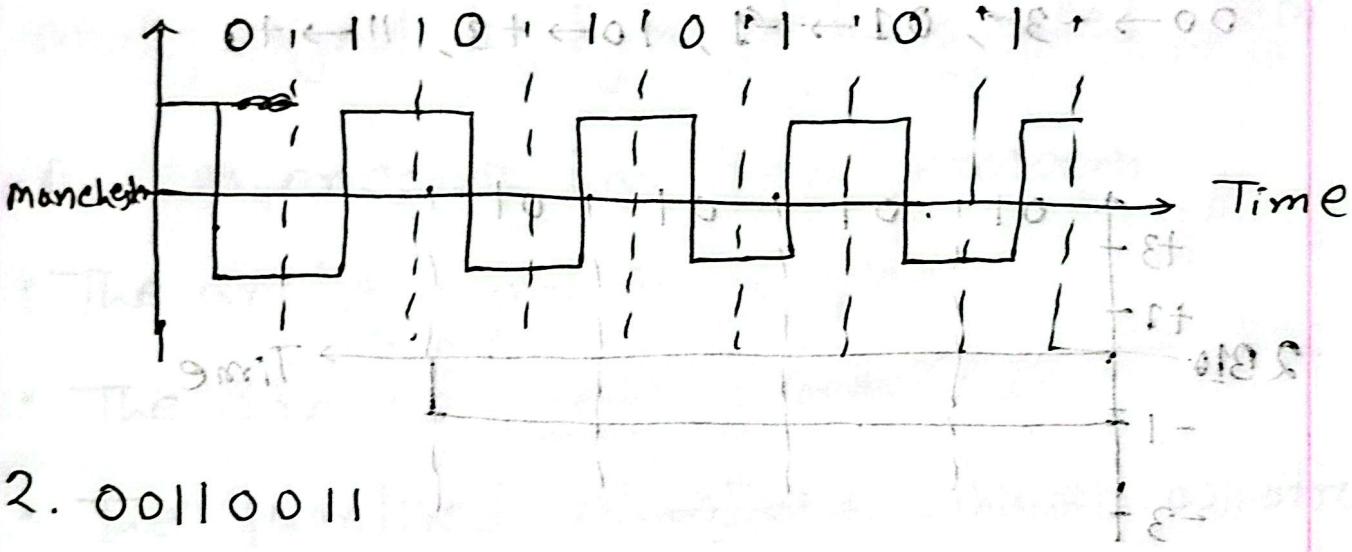


2. 00110011

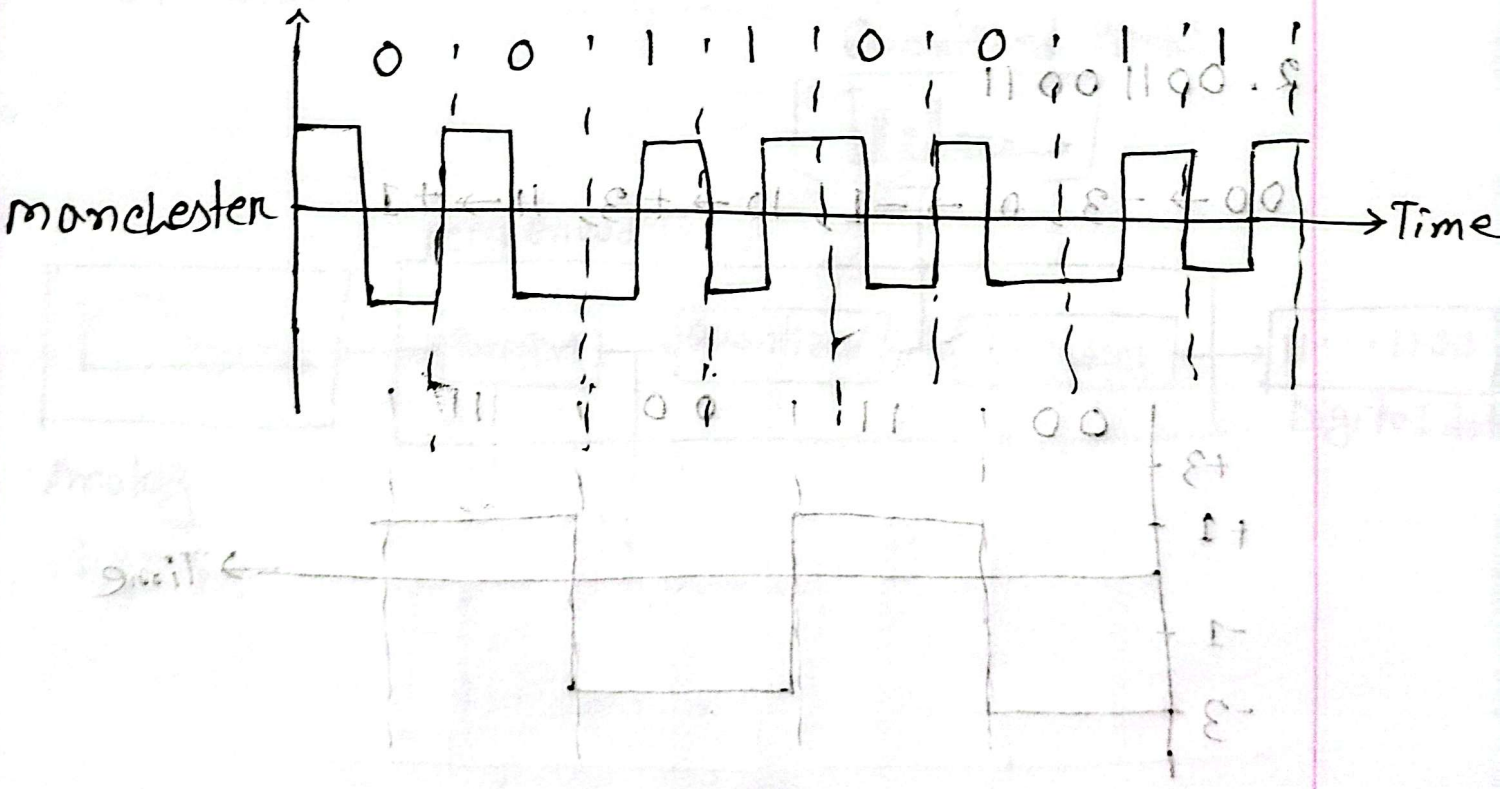


- **manchester:** 0 ⇒ ⎿ 1 = ⎾

1. 01010101



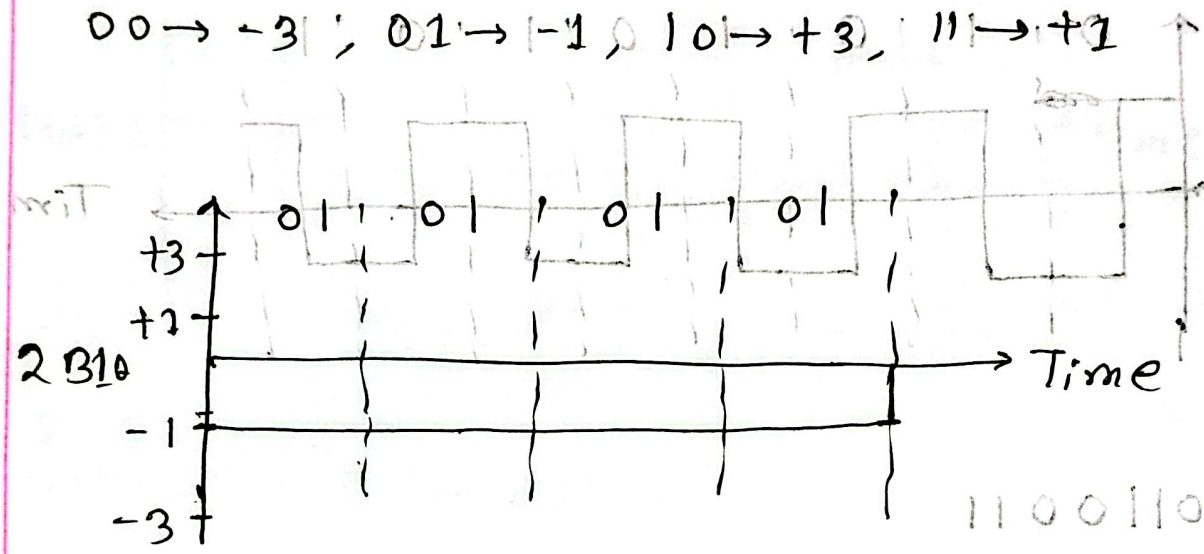
2. 00110011



• 2B1Q :

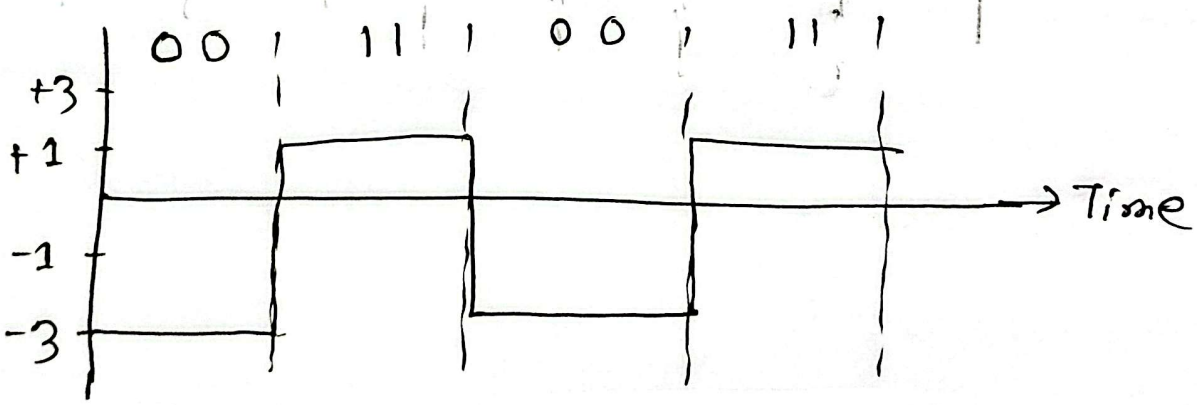
1. 01010101

00 → −3 , 01 → −1 , 10 → +3 , 11 → +1



2. 00110011

00 → −3 , 01 → −1 , 10 → +3 , 11 → +1

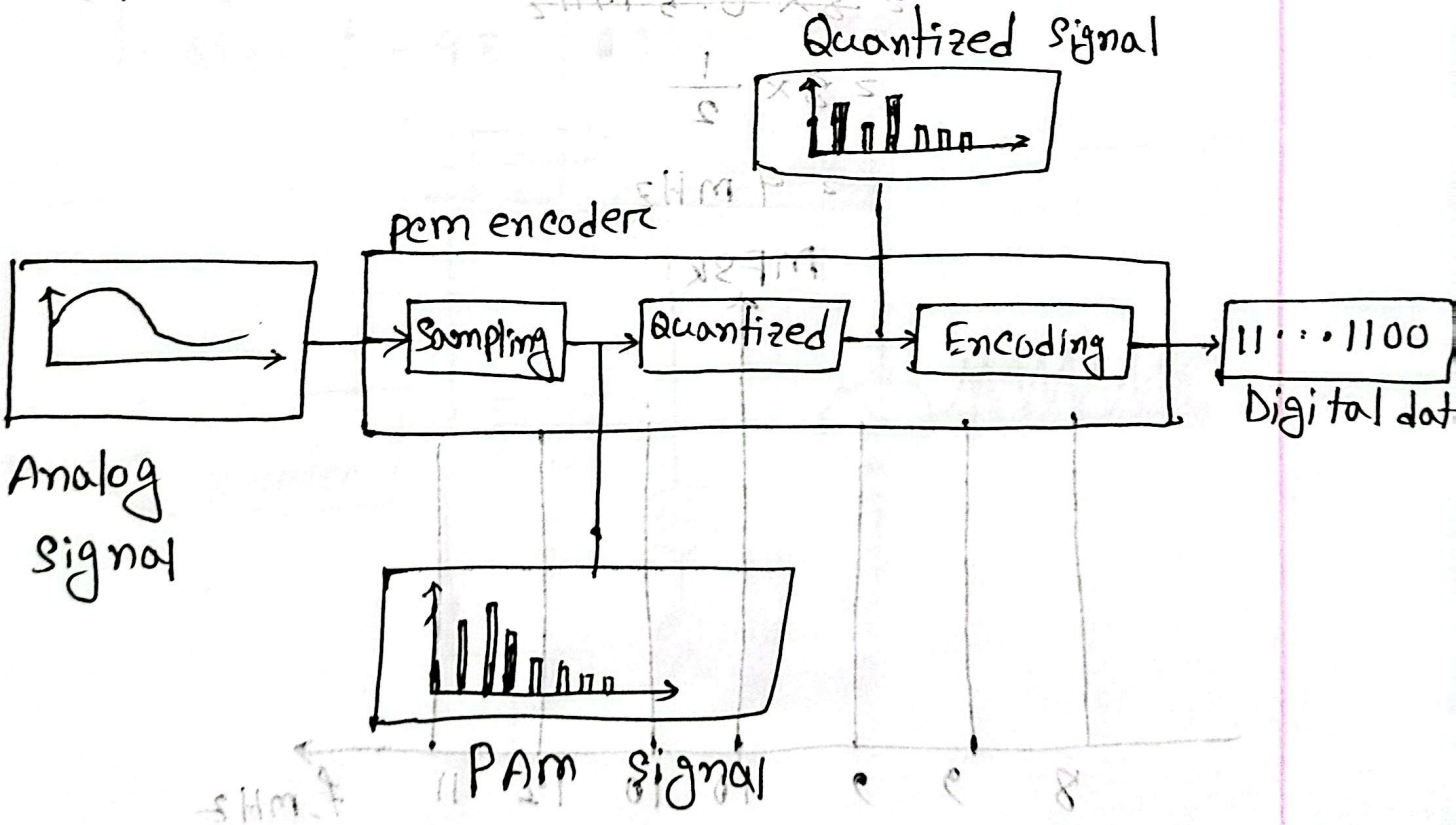


3. Pulse code modulation (PCM):

The most common technique to change an analog signal to digital data is called PCM.

A PCM encoder has three processes.

- The analog signal is sampled.
- The sampled signal is quantized.
- The quantized values are encoded as streams of bits.



4. Given,

Bit rate $R_b = 3$ Mbps

send data = 3 bit per symbol

carrier frequency $f_c = 10$ mHz

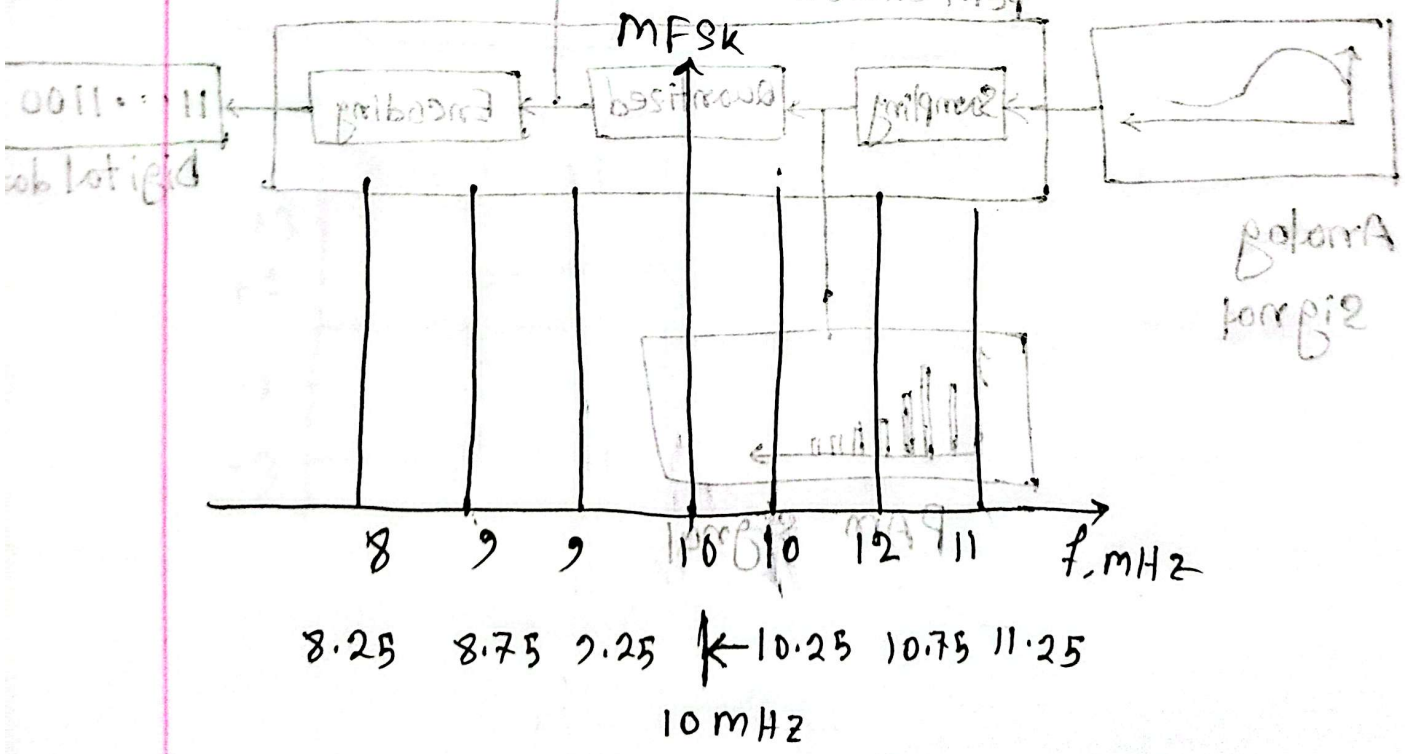
$\therefore$ Number of levels $(m) = 2^3 = 8$

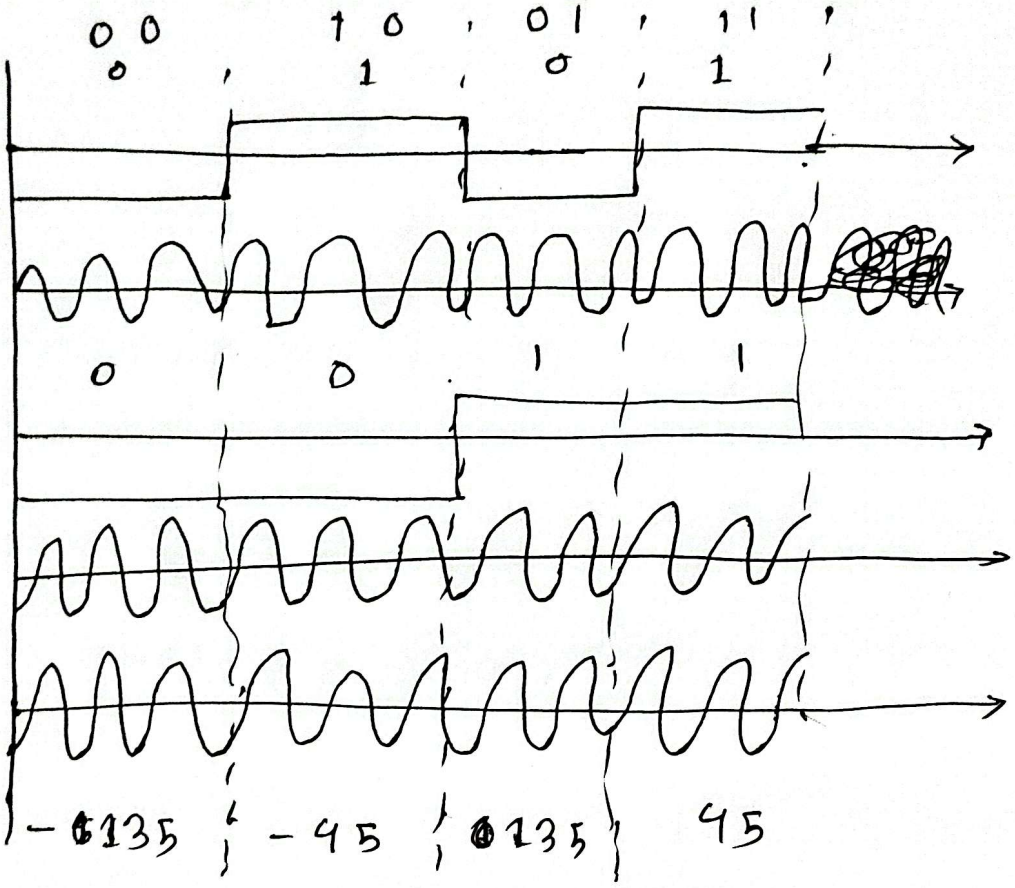
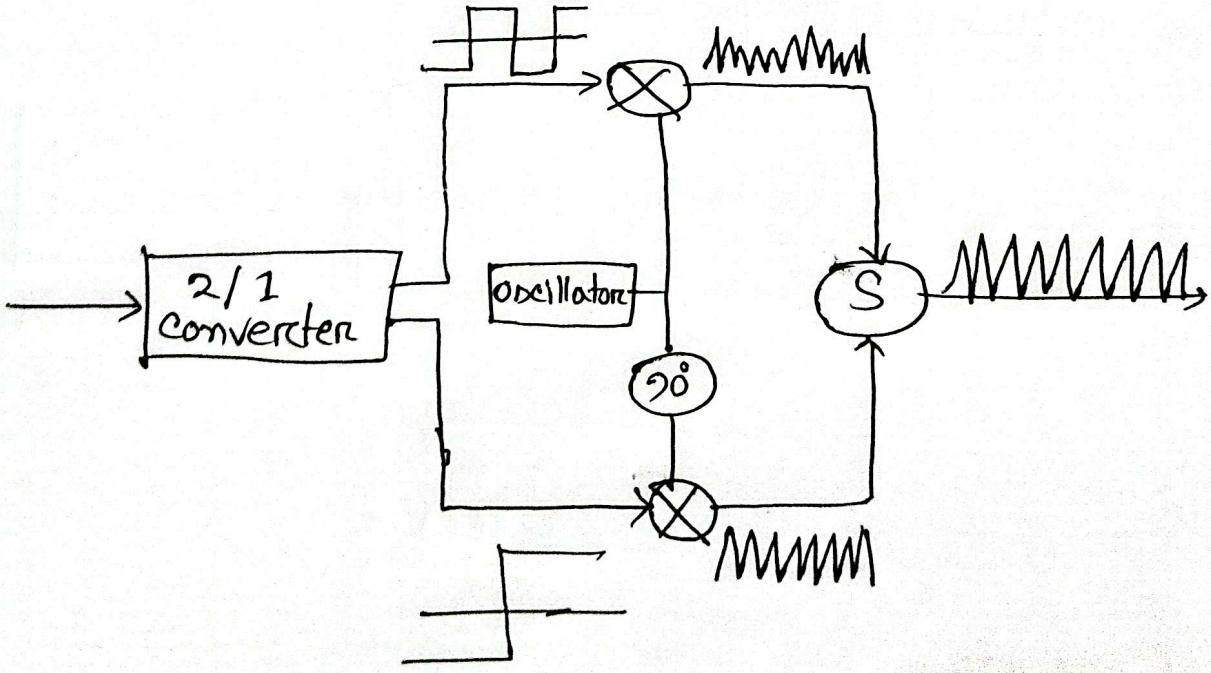
- Baud rate $= \dfrac{3 \text{ mbps}}{3 \text{ bits/symbol}} = 1$ mbaud
- Bandwidth $= m \times \dfrac{R_s}{2}$

$= \cancel{8 \times 0.5 \text{ mHz}}$

$= 8 \times \dfrac{1}{2}$

$= 4$ mHz



0 0	+1	+1	+45°
0 1	−1	+1	+135°
1 0	−1	−1	−135°
1 1	+1	−1	−45°

5.