**Scheme of Evaluation**
**Internal Assessment Test 1 –JUL 2022**

| Sub: | Data Communication | | | | | | | Code: | 18CS46 |
|---|---|---|---|---|---|---|---|---|---|
| Date: | 12/7/2022 | Duration: | 90mins | Max Marks: | 50 | Sem: | IV | Branch: | ISE |

**Note:** **Answer Any five full questions.**

| Question # | | Description | Marks Distribution | | Max Marks |
|---|---|---|---|---|---|
| 1 | a) | Discuss various network types based on their limit on usage with respect to geographical area.<br>**Diagram**<br>**Explanation** | 2M+3M | 5M | 10M |
| | b) | What are the different ways in which dataflow is categorized in data communication.<br>**Diagram**<br>**Explanation** | 2M+3M | 5M | |
| 2 | | Represent the sequence 01101110101 using polar and bi-phase schemes.<br>**Writing polar scheme**<br>**Writing biphase schemes** | 5M+5M | 10M | 10M |
| 3 | a) | List and explain different sampling techniques used in PCM encoding scheme.<br>**Listing**<br>**Diagram**<br>**Explanation** | 1M+2M+3M | 6M | 10M |

| | | | | | |
|---|---|---|---|---|---|
| 3 | b) | A complex low-pass signal has a bandwidth of 200 kHz. What is the minimum sampling rate for this signal? Calculate the same for band-pass signal for the same bandwidth.<br>**Solving for low pass signal with formula**<br>**Solving for bandpass signal** | 2M+2M | 4M | |
| 4 | a) | Explain the different causes for transmission impairment during signal transmission through media.<br><br>**Diagrams**<br>**Explanation for each** | 2M<br>6M | 8M | 10M |
| | b) | A digital signal has nine levels. How many bits are needed per level?<br>**Formula**<br>**Solving** | 1M+1M | 2M | |
| 5 | | List out and explain the features, pros and cons of the different network topologies with suitable diagrams.<br>**List**<br>**Explaining features with a diagram**<br>**Pros and cons** | 1M+5M + 4M | 10M | 10M |

| | | | | | |
|---|---|---|---|---|---|
| 6 | a) | What is a noiseless channel? Find out maximum bit rate in a noiseless channel with bandwidth of 3000Hz transmitting a signal with two signal level.<br><br>**Definition**<br>**Formula+ Solving** | 1M+3M | 4M | 10M |
| 6 | b) | Discuss the technique used to convert an analog signal to digital data.<br><br>**Diagram**<br><br>**Explanation** | 2M+4M | 6M | |

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**Note:** **Answer Any full five questions**

**Q1a). Discuss various network types based on their limit on usage with respect to geographical area.**
**Solution:**

Two popular types of networks:
1) LAN (Local Area Network) &
2) WAN (Wide Area Network)

**LAN**
• LAN is used to connect computers in a single office, building or campus (Figure 1.8).
• LAN is usually privately owned network.
• A LAN can be simple or complex.
1) Simple: LAN may contain 2 PCs and a printer.
2) Complex: LAN can extend throughout a company.
• Each host in a LAN has an address that uniquely defines the host in the LAN.
• A packet sent by a host to another host carries both source host's and destination host's addresses.
• LANs use a smart connecting switch.
• The switch is able to
→ recognize the destination address of the packet &
→ guide the packet to its destination.
• The switch
→ reduces the traffic in the LAN &
→ allows more than one pair to communicate with each other at the same time.

Advantages:
**1) Resource Sharing**
· Computer resources like printers and hard disks can be shared by all devices on the network.
**2) Expansion**
· Nowadays, LANs are connected to WANs to create communication at a wider level.

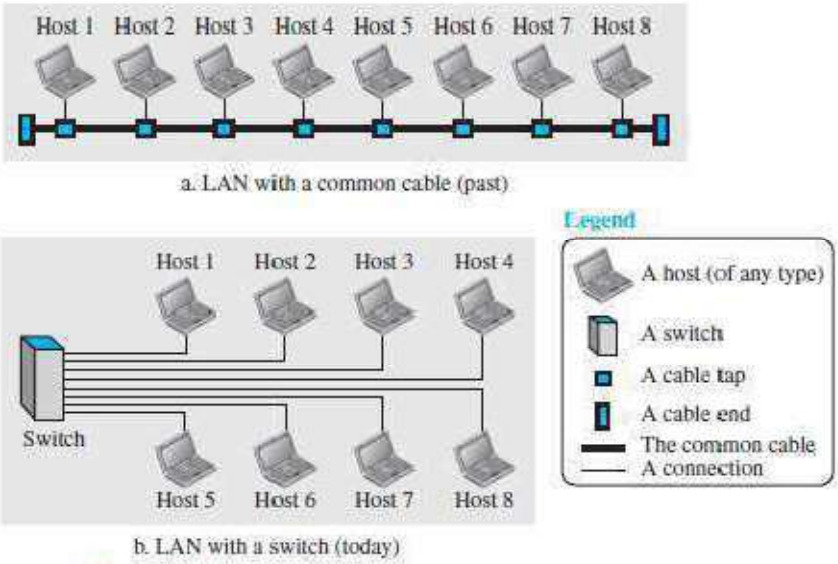



Figure 1.8 *An isolated LAN in the past and today*

**WAN**

- WAN is used to connect computers anywhere in the world.
- WAN can cover larger geographical area. It can cover cities, countries and even continents.
- WAN interconnects connecting devices such as switches, routers, or modems.
- Normally, WAN is

→ created & run by communication companies (Ex: BSNL, Airtel)
→leased by an organization that uses it.

- A WAN can be of 2 types:

**1) Point-to-Point WAN**

· A point-to-point WAN is a network that connects 2 communicating devices through a transmission media (Figure 1.9).

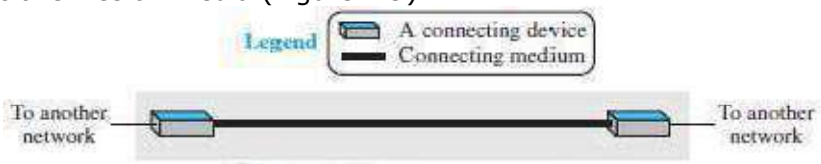



Figure 1.9 *A point-to-point WAN*

**2) Switched WAN**

· A switched WAN is a network with more than two ends.

· The switched WAN can be the backbones that connect the Internet.

· A switched WAN is a combination of several point-to-point WANs that are connected by switches (Figure 1.10).

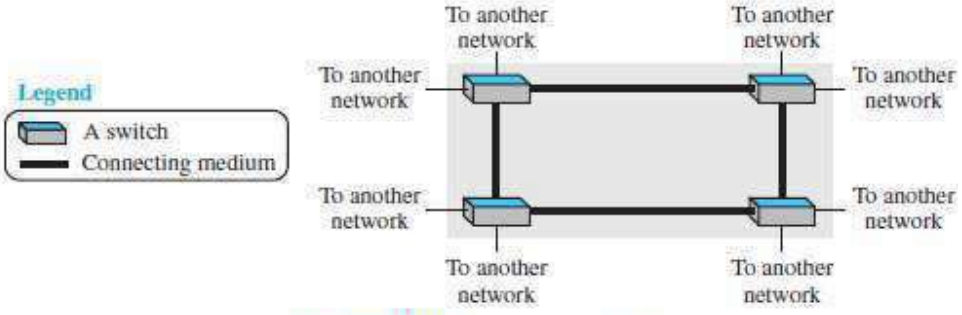



Figure 1.10 *A switched WAN*

**Q1b). What are the different ways in which dataflow is categorized in data communication.**

Three ways of data-flow between 2 devices (Figure 1.2):
1) Simplex
2) Half-duplex
3) Full-duplex

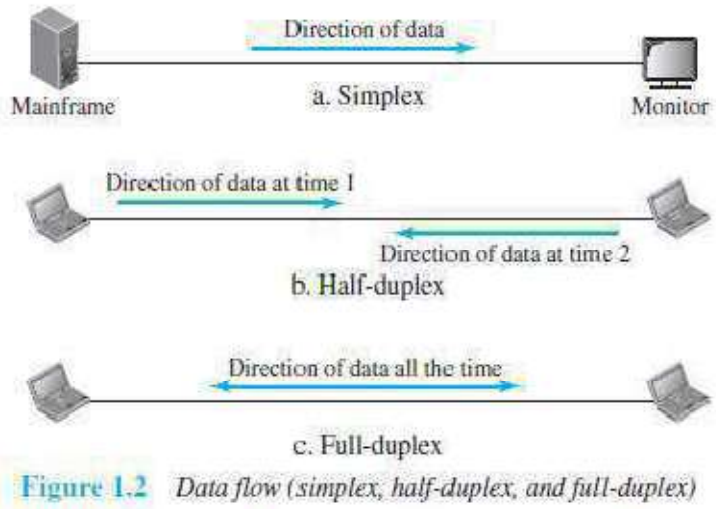



Figure 1.2 *Data flow (simplex, half-duplex, and full-duplex)*

**1) Simplex**

· The communication is unidirectional

(For ex: The simplex mode is like a one-way street).

· On a link, out of 2 devices:

i) Only one device can transmit.

ii) Another device can only receive.

· For example (Figure 1.2a):

The monitor can only accept output.

· Entire-capacity of channel is used to send the data in one direction.

**2) Half Duplex**

· Both the stations can transmit as well as receive but not at the same time.

(For ex: The half-duplex mode is like a one-lane road with 2 directional traffic). ·

When one station is sending, the other can only receive and vice-versa.

· For example (Figure 1.2b): Walkie-talkies

· Entire-capacity of a channel is used by one of the 2 stations that are transmitting the data.

**3) Full Duplex**

· Both stations can transmit and receive at the same time.

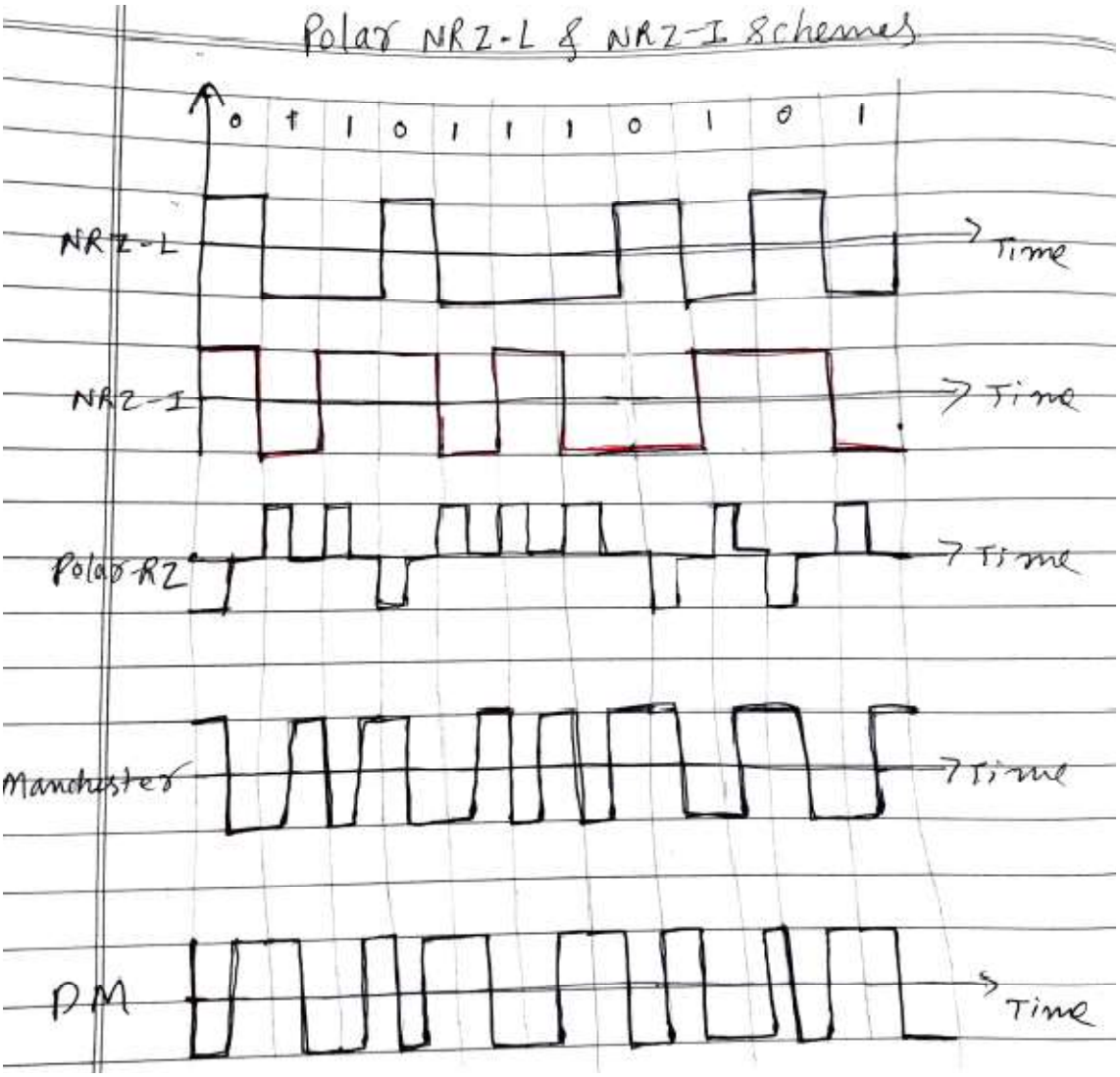
(For ex: The full-duplex is like a 2-way street with traffic flowing in both directions at the same time).

· For example (Figure 1.2c):

Mobile phones (When 2 people are communicating by a telephone line, both can listen and talk at the same time)

· Entire-capacity of a channel is shared by both the stations that are transmitting the data.

**Q2. Represent the sequence 01101110101 using polar and bi-phase schemes.**




**Q3a). List and explain different sampling techniques used in PCM encoding scheme.**

Three sampling methods (Figure 4.22):

**1) Ideal Sampling**

· This method is difficult to implement.

**2) Natural Sampling**

· A high-speed switch is turned ON for only the small period of time when the sampling occurs. The result is a sequence of samples that retains the shape of the analog-signal.

**3) Flat Top Sampling**

· The most common sampling method is sample and hold.

· Sample and hold method creates flat-top samples.

· This method is sometimes referred to as *PAM* (pulse amplitude modulation).

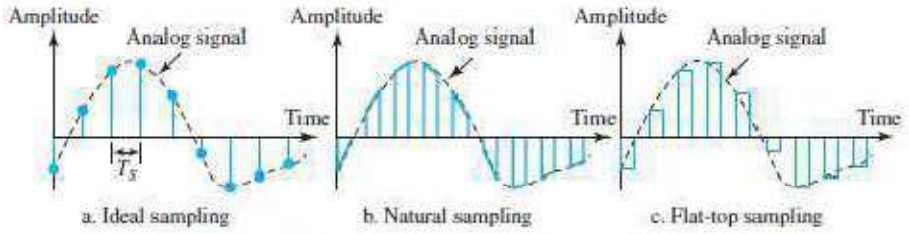



Figure 4.22 *Three different sampling methods for PCM*

**Q3b). A complex low-pass signal has a bandwidth of 200 kHz. What is the minimum sampling rate for this signal? Calculate the same for band-pass signal for the same bandwidth.**
**Solution**

The bandwidth of a low-pass signal is between 0 and *f, where f is the maximum frequency in the* signal. Therefore, we can sample this signal at 2 times the highest frequency ($f_{max}$ =200 kHz).
$f_s$=2 x $f_{max}$. The sampling rate is therefore 400,000 samples per second.

We cannot find the minimum sampling rate in the case of bandpass signal because we do not know where the bandwidth starts or ends. We do not know the maximum frequency in the signal.

**Q4a). Explain the different causes for transmission impairment during signal transmission through media.**

Three causes of impairment are (Figure 3.26):
1) Attenuation
2) Distortion &
3) Noise.

**Attenuation**
• As signal travels through the medium, its strength decreases as distance increases. This is called
attenuation (Figure 3.27).
• As the distance increases, attenuation also increases.
• For example:
Voice-data becomes weak over the distance & loses its contents beyond a certain distance.
• To compensate for this loss, amplifiers are used to amplify the signal.

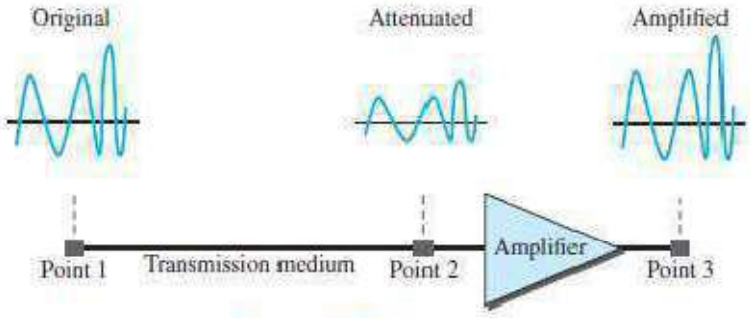



Figure 3.27 *Attenuation*

**Distortion**
• Distortion means that the signal changes its form or shape (Figure 3.29).
• Distortion can occur in a composite signal made of different frequencies.
• Different signal-components
→ have different propagation speed through a medium.
→ have different delays in arriving at the final destination.

• Differences in delay create a difference in phase if delay is not same as the period-duration.
• Signal-components at the receiver have phases different from what they had at the sender.
• The shape of the composite signal is therefore not the same.

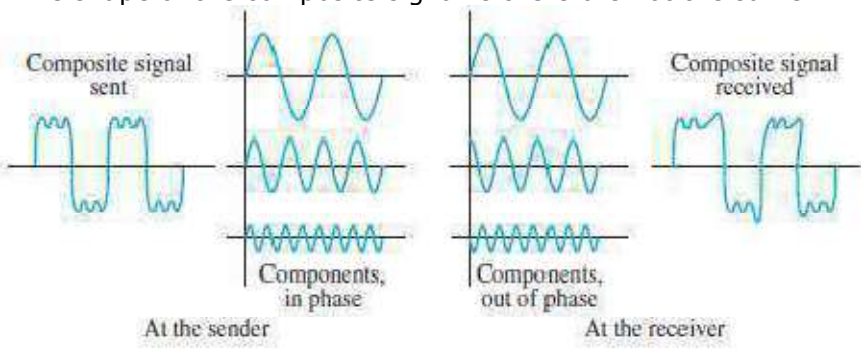



Figure 3.29 *Distortion*

**Noise**

• Noise is defined as an unwanted data (Figure 3.30).
• In other words, noise is the external energy that corrupts a signal.
• Due to noise, it is difficult to retrieve the original data/information.
• Four types of noise:

**i) Thermal Noise**

· It is random motion of electrons in wire which creates extra signal not originally sent by transmitter.

**ii) Induced Noise**

· Induced noise comes from sources such as motors & appliances. · These devices act as a sending-antenna.
The transmission-medium acts as the receiving-antenna.

**iii) Crosstalk**

· Crosstalk is the effect of one wire on the other.
· One wire acts as a sending-antenna and the other as the receiving-antenna. **iv)**

**Impulse Noise**

· Impulse Noise is a spike that comes from power-lines, lightning, and so on.
(spike · a signal with high energy in a very short time)

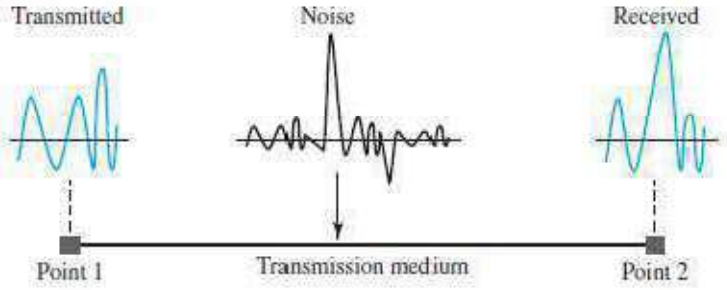



Figure 3.30 *Noise*

**Q4b). A digital signal has nine levels. How many bits are needed per level?**
**Solution:**

Number of bits per level = $\log_2 9 = 3.17$bits. However, this answer is not realistic. The number of bits sent per level needs to be an integer as well as a power of 2.

**Q5. List out and explain the features, pros and cons of the different network topologies with suitable**

**diagrams.**

Four basic topologies are:
1) Mesh
2) Star
3) Bus and
4) Ring

**Bus Topology**
• All the devices are connected to the single cable called bus (Figure 1.4).
• Every device communicates with the other device through this bus.
• A data from the source is broadcasted to all devices connected to the bus.
• Only the intended-receiver, whose physical-address matches, accepts the data.


Figure 1.4 *A bus topology connecting three stations*

Advantages:
1) Easy installation.
2) Cable required is the least compared to mesh/star topologies.
3) Redundancy is eliminated.
4) Costs less (Compared to mesh/star topologies).
5) Mostly used in small networks. Good for LAN.
• Disadvantages:
1) Difficult to detect and troubleshoot fault.
2) Signal reflection at the taps can cause degradation in quality.
3) A fault/break in the cable stops all transmission.
4) There is a limit on
i) Cable length
ii) Number of nodes that can be connected.
5) Security is very low because all the devices receive the data sent from the source.

**Star Topology**
• All the devices are connected to a central controller called a hub (Figure 1.5).
• There exists a dedicated point-to-point link between a device & a hub.
• The devices are not directly linked to one another. Thus, there is no direct traffic between devices.
• The hub acts as a junction:
If device-1 wants to send data to device-2, the device-1 sends the data to the hub, then the hub relays the data to the device-2.

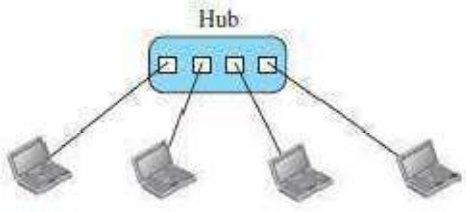



Figure 1.5 *A star topology connecting four stations*

Advantages:
1) Less expensive: Each device needs only one link & one I/O port to connect it to any devices.
2) Easy installation & reconfiguration: Nodes can be added/removed w/o affecting the network.
3) Robustness: If one link fails, it does not affect the entire system.
4) Easy to detect and troubleshoot fault.

5) Centralized management: The hub manages and controls the whole network.
• Disadvantages:
1) Single point of failure: If the hub goes down, the whole network is dead.
2) Cable length required is the more compared to bus/ring topologies.
3) Number of nodes in network depends on capacity of hub.

**Ring Topology**

• Each device is connected to the next, forming a ring (Figure 1.6).
• There are only two neighbors for each device.
• Data travels around the network in one direction till the destination is reached.
• Sending and receiving of data takes place by the help of token.
• Each device has a repeater.

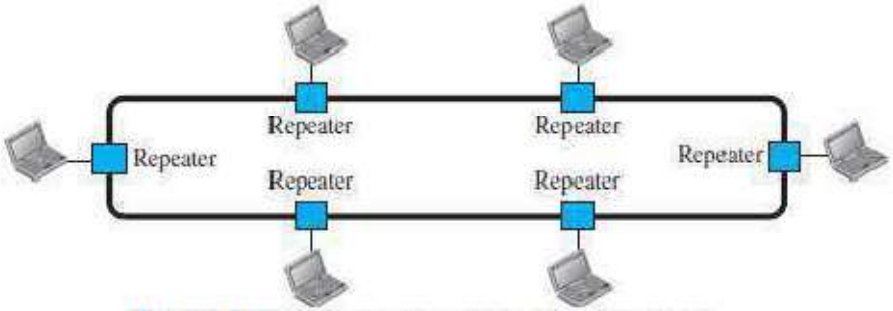



Figure 1.6 *A ring topology connecting six stations*

Advantages:
1) Easy installation and reconfiguration.
To add/delete a device, requires changing only 2 connections.
2) Fault isolation is simplified.
If one device does not receive a signal within a specified period, it can issue an alarm.
The alarm alerts the network-operator to the problem and its location.
3) Congestion reduced: Because all the traffic flows in only one direction.
• Disadvantages:
1) Unidirectional traffic.
2) A fault in the ring/device stops all transmission.
The above 2 drawbacks can be overcome by using dual ring.
3) There is a limit on
i) Cable length &
ii) Number of nodes that can be connected.
4) Slower: Each data must pass through all the devices between source and destination.

**Mesh Topology**

• All the devices are connected to each other (Figure 1.7).
• There exists a dedicated point-to-point link between all devices.
• There are n(n-1) physical channels to link n devices.
• Every device not only sends its own data but also relays data from other nodes.
• For 'n' nodes,
→ there are n(n-1) physical-links
→ there are n(n-1)/2 duplex-mode links
• Every device must have (n-1) I/O ports to be connected to the other (n-1) devices.

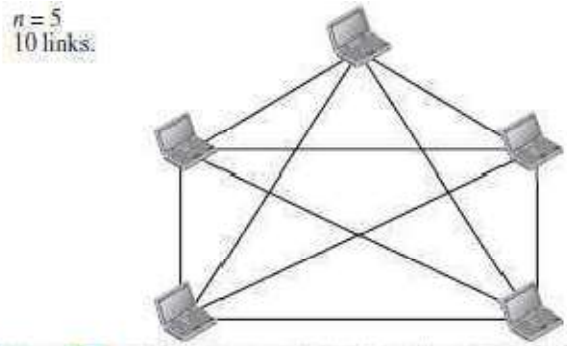



Figure 1.7 *A fully connected mesh topology (five devices)*

Advantages:
1) Congestion reduced: Each connection can carry its own data load.
2) Robustness: If one link fails, it does not affect the entire system.
3) Security: When a data travels on a dedicated-line, only intended-receiver can see the data.
4) Easy fault identification & fault isolation: Traffic can be re-routed to avoid problematic links.
• Disadvantages:
1) Difficult installation and reconfiguration.
2) Bulk of wiring occupies more space than available space.
3) Very expensive: as there are many redundant connections.
4) Not mostly used in computer networks. It is commonly used in wireless networks.
5) High redundancy of the network-connections.

**Q6a). What is a noiseless channel? Find out maximum bit rate in a noiseless channel with bandwidth of 3000Hz transmitting a signal with two signal level.**

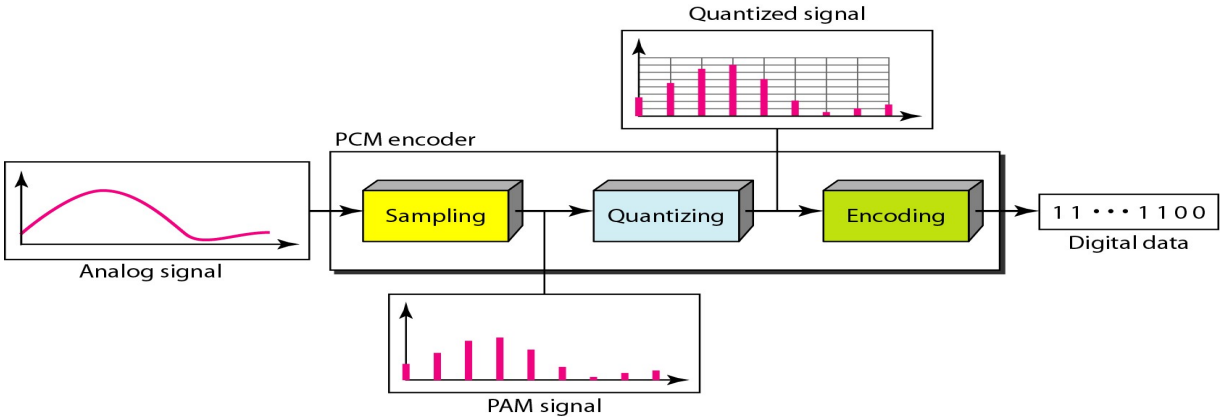
A noiseless channel is the one which is an idealistic channel in which no frames are lost, corrupted or duplicated.

Consider a noiseless channel with a bandwidth of 3000 Hz transmitting a signal with two signal levels. The maximum bit rate can be calculated as

$$\text{BitRate} = 2 \times 3000 \times \log_2 2 = 6000 \text{ bps}$$

**Q6b). Discuss the technique used to convert an analog signal to digital data.**

PCM is a technique used to change an analog signal to digital data (digitization).
• PCM has encoder at the sender and decoder at the receiver.
• The encoder has 3 processes (Figure 4.21):
1) Sampling
2) Quantization &
3) Encoding.




**1. Sampling**

• We convert the continuous time signal (analog) into the discrete time signal (digital).
• Pulses from the analog-signal are sampled every $T_s$ sec
where $T_s$ is the sample-interval or period.
• The inverse of the sampling-interval is called the sampling-frequency (or sampling-rate).
• Sampling-frequency is given by $f_s = 1/T_s$

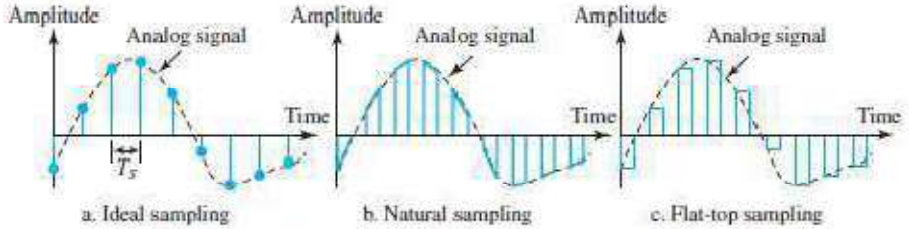



Figure 4.22 *Three different sampling methods for PCM*

2. **Quantization**

• The sampled-signal is quantized.
• Result of sampling is a set of pulses with amplitude-values b/w max & min amplitudes of the signal.
• Four steps in quantization:
1) We assume that the original analog-signal has amplitudes between $V_{min}$ & $V_{max}$.
2) We divide the range into L zones, each of height Δ(delta).
where L = number of levels.
3) We assign quantized values of 0 to (L-1) to the midpoint of each zone.
4) We approximate the value of the sample amplitude to the quantized values.

**3. Encoding**

It's the process of converting quantization codes obtained in the previous process to the binary codes. The encoded words are the final products of the conversion.

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