UNIT–2 : Telecommunication Systems and Local Area Networks (PYQ Solution)

PART–A Answers (≈70 Words Each)

Q1. What is the primary function of a telephone hybrid in a telephone system? (2025)

A telephone hybrid converts between the 2-wire local loop (both directions on one pair) and the 4-wire circuit (separate transmit and receive pairs) used in exchanges and long-distance trunks.

It also keeps the user's own voice from going back strongly into the earpiece (sidetone control) and reduces echo.

Q2. What is the need of CPG message in ISUP protocol? (2022)

ISUP (ISDN User Part) is the part of SS7 signalling that sets up and releases calls between exchanges.

CPG (Call Progress) message is sent backward (from called side to calling side) after the ACM, to tell the calling exchange that an event happened during call setup, e.g. the called phone is ringing (alerting), the call is forwarded, or in-band information (tone/announcement) is available.

Q3. What is a paging system? (Expected)

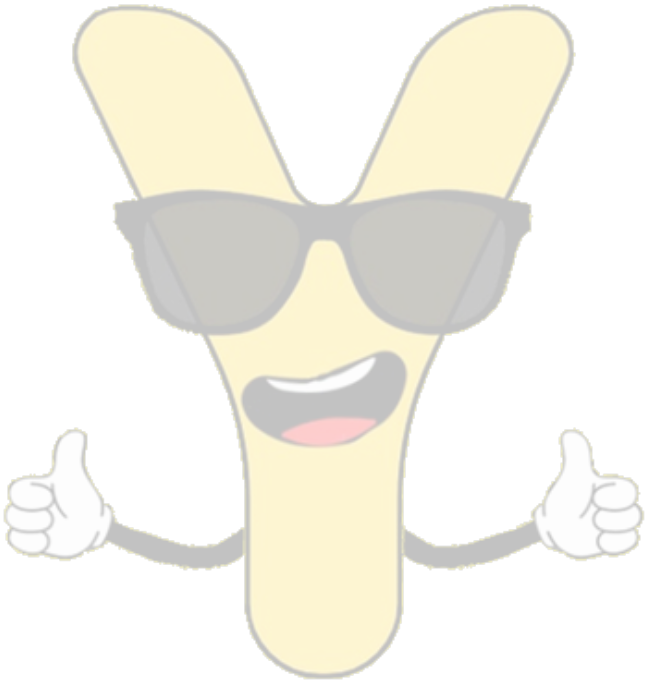
A paging system is a one-way (sometimes two-way) radio system that sends short alert, numeric or text messages to a small pocket receiver called a pager (beeper).

The caller contacts the paging centre; the message is broadcast on a VHF/UHF channel using a protocol like POCSAG/FLEX; only the pager with the matching address (capcode) shows it. Used in hospitals and emergency services.

Q4. Name two common types of LAN hardware. (2025)

1. **Network Interface Card (NIC): connects a computer to the LAN; has a unique 48-bit MAC address.**
2. **Switch (or Hub): central device that connects all computers in a star LAN; a switch sends frames only to the correct port.**

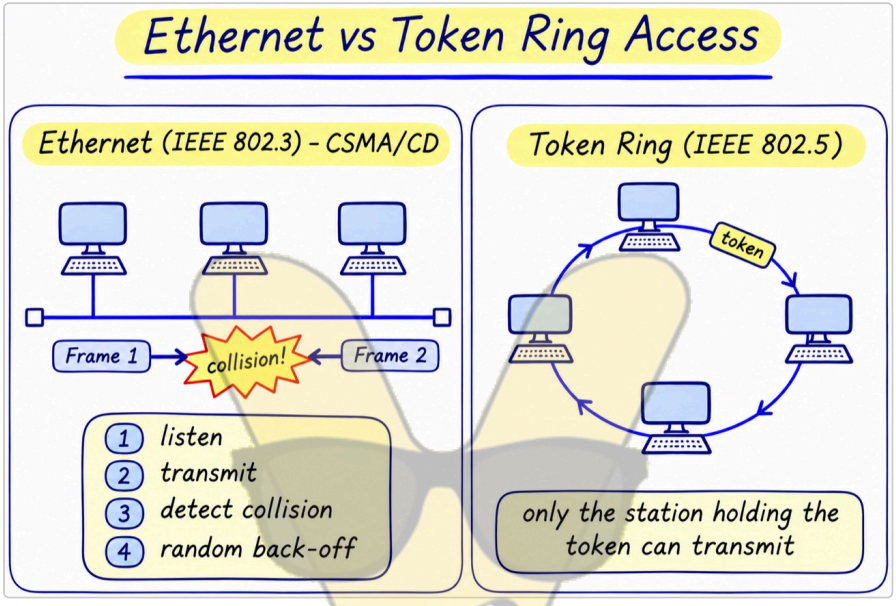
Others: router, repeater, bridge, access point, cables (UTP Cat-6, coaxial, fiber) and RJ-45 connectors.



PART–B Answers (≈250 Words Each)

Q1. Compare and contrast Ethernet LANs and Token Ring LANs based on their access methods and topologies. (2025)

Both are LAN standards of the IEEE 802 family, but they share the cable in very different ways.



Ethernet (IEEE 802.3) uses **CSMA/CD** (Carrier Sense Multiple Access with Collision Detection): a station listens; if the line is free it sends; if two send together there is a **collision**, both stop, wait a random time (back-off) and retry. Access is **random**.

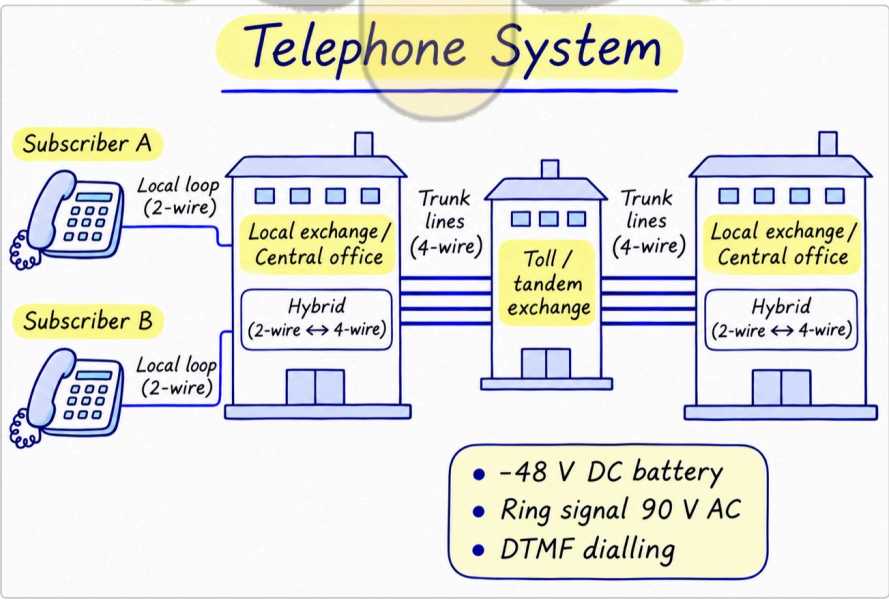
Token Ring (IEEE 802.5) passes a special frame called the **token** around the ring. Only the station holding the token can transmit; after sending it releases the token to the next station. Access is **controlled and fair** — no collisions.

Point	Ethernet	Token Ring
Standard	IEEE 802.3	IEEE 802.5 (IBM)
Access method	CSMA/CD (contention)	Token passing
Collisions	Possible	None
Topology	Bus (old), **star** with switch (now)	Logical ring, physical star (MAU)
Speed	10 Mbps → 100 Mbps → 1/10/100 Gbps	4 / 16 Mbps (100 Mbps later)
Delay	Random, not guaranteed	Fixed maximum (deterministic)
Heavy load	Performance falls (many collisions)	Stays steady
Cost	Cheap, simple	Costly, complex
Status	Used everywhere today	Obsolete

Conclusion: Token Ring gives predictable delay, but Ethernet won because it is cheaper, simpler and much faster with switches (full-duplex switched Ethernet has no collisions at all).

Q2. Explain the working of a telephone system with a neat diagram. (Expected)

The **telephone system (PSTN)** connects any two telephones through a network of exchanges.



Parts:

1. **Telephone set:** microphone (converts voice to electrical signal), receiver (speaker), keypad (DTMF dialling), ringer and hybrid.
2. **Local loop:** a 2-wire twisted pair from the home to the local exchange. The exchange supplies **−48 V DC** to power the phone.
3. **Local exchange (central office):** detects off-hook, gives dial tone, reads the dialled digits and switches the call.
4. **Trunks:** 4-wire / digital (PCM, fiber) lines between exchanges; long-distance calls go through **toll/tandem exchanges**.

How a call works:

1. Caller lifts the handset → loop current flows → exchange gives **dial tone**.
2. Caller dials → DTMF tones (two frequencies per key) reach the exchange.
3. Exchange finds the route (using **SS7 signalling**) and sends **ringing voltage (~90 V AC)** to the called phone, and ringback tone to the caller.
4. Called party lifts handset → speech path is connected; voice is digitised at 64 kbps (PCM) inside the network.
5. When either hangs up (on-hook), the exchange releases the circuit.

The PSTN is **circuit switched**: a fixed path is reserved for the whole call.

Q3. Explain Internet telephony (VoIP). (Expected)

Internet telephony or **VoIP (Voice over Internet Protocol)** carries voice calls as **data packets** over the Internet instead of over a dedicated telephone circuit.

Working:

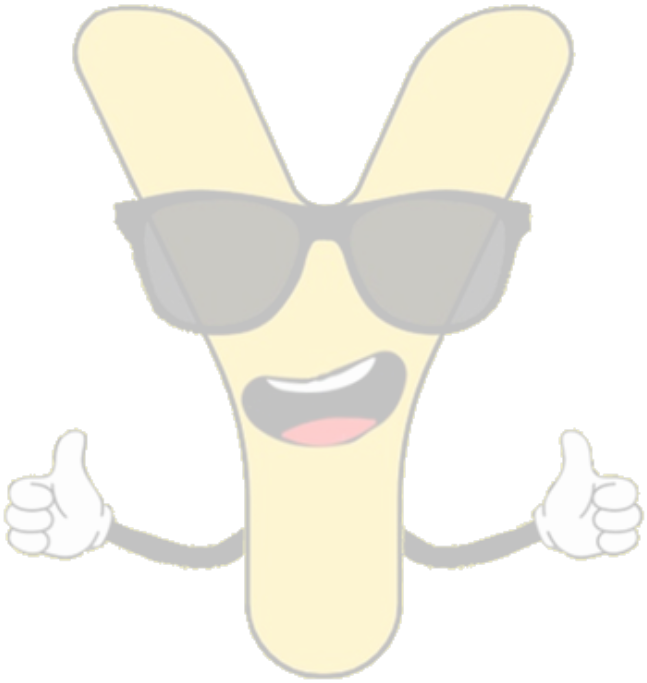
1. The voice is sampled and digitised, then **compressed** by a codec (G.711, G.729, Opus).
2. It is cut into small **packets** (20 ms of speech each) and sent using **RTP over UDP/IP**.
3. **Signalling** protocols (**SIP** or H.323) set up, ring and end the call.
4. At the receiver a **jitter buffer** puts packets in order and smooths delay; the codec turns them back into sound.
5. A **gateway** connects VoIP to normal phones on the PSTN.

Devices: softphone apps (WhatsApp, Zoom), IP phones, ATA adapters for old phones.

Advantages: very cheap or free calls, one network for data and voice, video and conferencing features, works anywhere with Internet.

Disadvantages: quality depends on Internet (delay, **jitter**, packet loss), needs power and Internet, emergency call location is harder, security risks.

Packet switched vs circuit switched: VoIP shares the link with other traffic (efficient), the PSTN reserves a path (reliable).

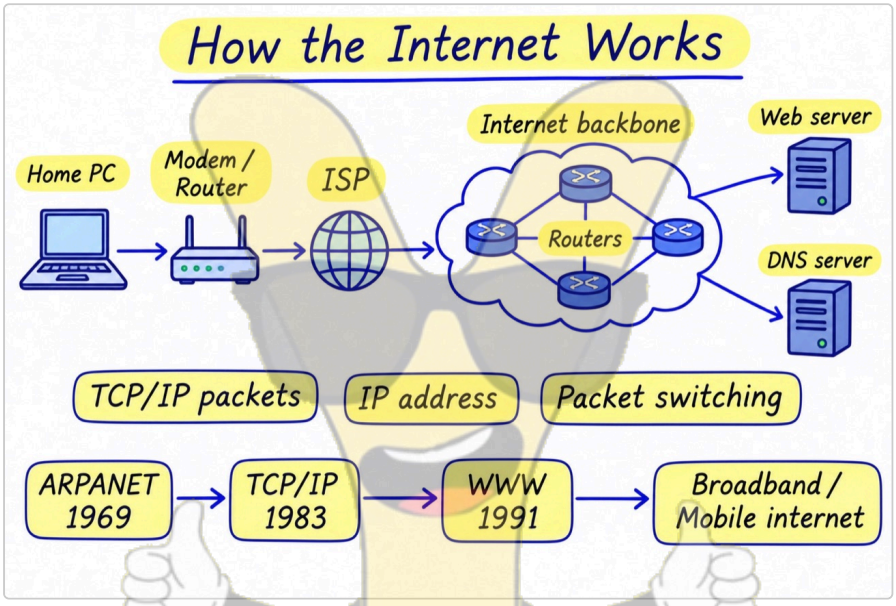


PART–C Answers (≈500 Words Each)

Q1. (a) Discuss the fundamental principles of the Internet and its evolution as a telecommunication system. (b) Explain the different layers involved in a typical Local Area Network (LAN) architecture and their respective functions. (2025)

(a) The Internet

The **Internet** is a worldwide **network of networks** that connects billions of devices using the common **TCP/IP** protocols.



Fundamental principles:

1. **Packet switching:** data is divided into packets; each packet travels independently through routers and is joined again at the destination. Links are shared efficiently.
2. **TCP/IP protocol suite: IP** gives every device an **IP address** and routes packets; **TCP** gives reliable, in-order delivery (UDP is faster, no guarantee).
3. **Layered design:** application (HTTP, email, DNS), transport (TCP/UDP), internet (IP), network access (Ethernet, Wi-Fi).
4. **Routing:** routers choose paths using routing tables and protocols (OSPF, BGP).
5. **DNS:** converts names like theycotes.com into IP addresses.
6. **Client-server and end-to-end idea:** the network just carries packets; intelligence is in the end devices.

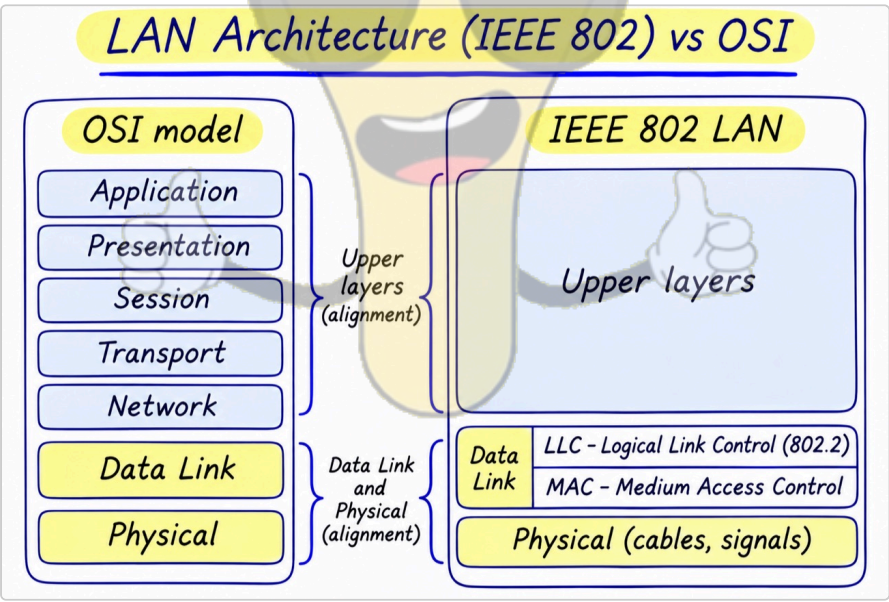
7. **ISPs:** users connect through Internet Service Providers, which connect to the high-speed **backbone**.

Evolution as a telecommunication system:

- **1969 ARPANET** (US defence research) — first packet-switched network.
- **1983** — ARPANET adopts **TCP/IP**; the Internet is born.
- **1991 World Wide Web** (Tim Berners-Lee) — web pages, browsers; public use grows.
- **1990s–2000s** — dial-up → DSL, cable and fiber broadband; email, e-commerce.
- **2007 onwards** — smartphones and **mobile internet (3G/4G/5G)**, cloud, social media.
- **Today** — voice (VoIP), video, TV and IoT all run on IP. The Internet has become the main telecom network, replacing much of the old circuit-switched telephone network.

(b) LAN architecture layers (IEEE 802 model)

The IEEE 802 standard covers only the **lowest two layers** of the OSI model, and splits the data link layer into two.



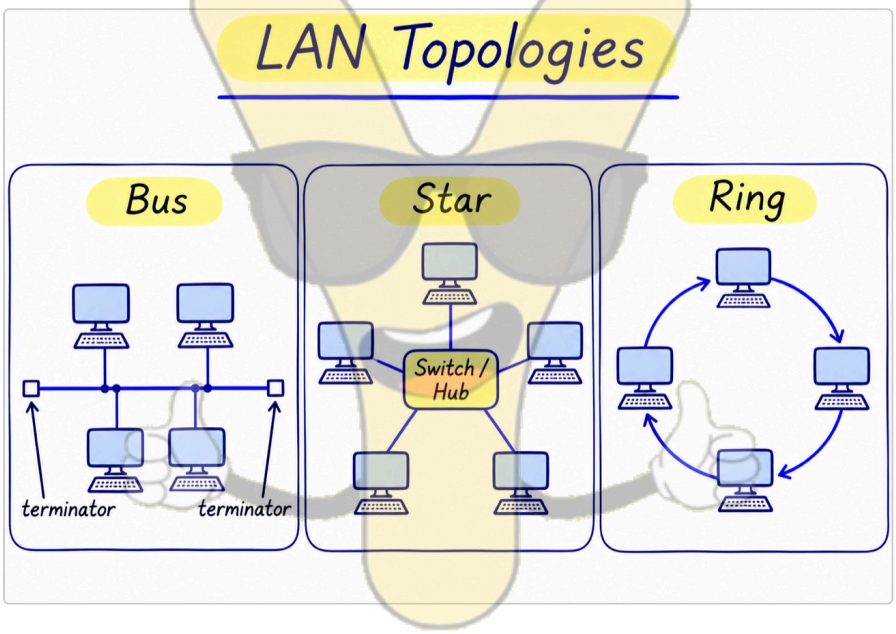
1. **Physical layer:** sends raw bits over the medium. Defines cable type (UTP, coaxial, fiber, radio), connectors, voltage levels, encoding (Manchester), data rate and topology.
2. **MAC (Medium Access Control) sub-layer:** decides **who may use the shared medium and when** — CSMA/CD (Ethernet), token passing (Token Ring), CSMA/CA (Wi-Fi). Also builds frames, adds **MAC addresses** and the **CRC** for error detection.

3. **LLC (Logical Link Control, IEEE 802.2) sub-layer:** gives a common interface to the network layer whatever MAC is used; provides flow control, error control and identifies the upper protocol (multiplexing).
4. **Upper layers (Network to Application):** IP routing, TCP, and user applications such as file sharing, printing and web.

Simple idea: Physical = the road, MAC = the traffic signal, LLC = the delivery manager talking to the upper layers.

Q2. Write a short note on Token Ring LAN. (2022)

Token Ring is a LAN technology developed by **IBM** and standardised as **IEEE 802.5**. Stations are connected in a **logical ring**, and a special small frame called the **token** controls who can send.



Working:

1. A free token circulates around the ring from station to station.
2. A station that wants to send **captures the token**, changes it into a frame start and attaches its data with destination address.
3. The frame travels around the ring; each station repeats it. The destination **copies** the data and sets the "frame copied" bits.
4. When the frame returns to the sender, the sender **removes** it and releases a new free token.
5. **Priority and reservation bits** in the token allow important stations to get access first.

6. One station acts as the **active monitor**: it removes lost or endlessly circulating frames and regenerates the token.

Physical layout: although logically a ring, stations are wired as a **star** to a **MAU (Multistation Access Unit)**, so a failed station can be bypassed.

Speed: 4 Mbps and 16 Mbps, with Differential Manchester encoding.

Advantages:

- No collisions, so performance stays good under heavy load.
- **Deterministic** — maximum waiting time is known, good for real-time traffic.
- Priority support.

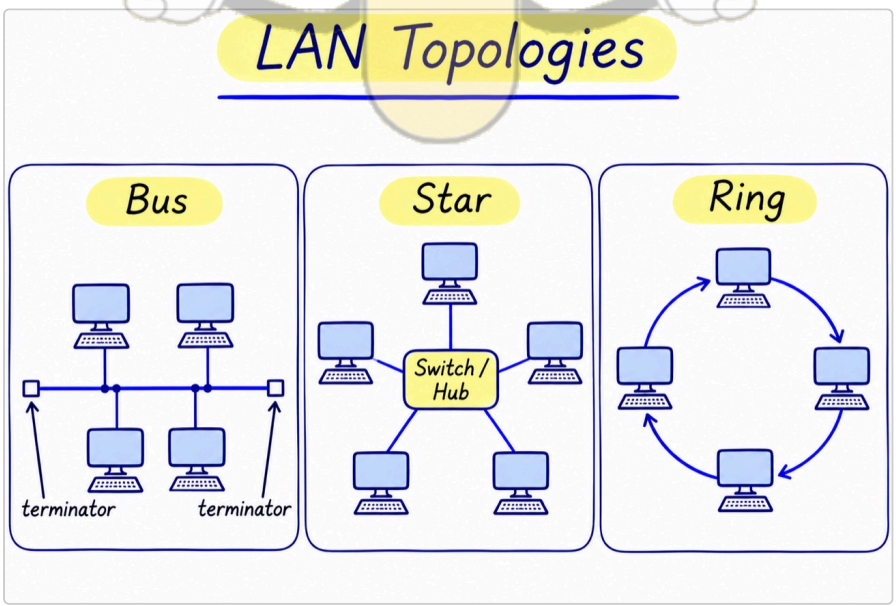
Disadvantages:

- More costly and complex than Ethernet.
- Token loss or a ring break needs recovery procedures.
- Lower speed than modern Ethernet; now obsolete. Its idea lives on in FDDI.

Q3. Explain network fundamentals: topologies, LAN hardware and Ethernet frame format. (Expected)

A **network** is two or more devices connected to share data and resources. By size: **PAN** (few metres), **LAN** (a building), **MAN** (a city), **WAN** (country/world).

Topologies (the layout of connections):



Topology	Description	Merit	Demerit
Bus	All on one cable	Cheap, easy	Cable fault stops all; collisions
Star	All to a central switch	Easy fault finding, popular	Switch failure stops all
Ring	Each to two neighbours in a loop	No collisions (token)	One break can stop ring
Mesh	Many direct links	Very reliable	Costly cabling
Tree/Hybrid	Stars joined in a hierarchy	Scalable	Depends on backbone

LAN hardware:

- **NIC:** network card with MAC address.
- **Cables:** UTP (Cat-5e/6) with RJ-45, coaxial, optical fiber.
- **Hub:** repeats signal to all ports (layer 1).
- **Switch:** sends frames only to the right port using MAC table (layer 2).
- **Repeater:** regenerates signals to extend distance.
- **Bridge:** joins two LAN segments.
- **Router:** connects different networks, routes by IP (layer 3).
- **Access point:** connects wireless devices to the wired LAN.

Ethernet (IEEE 802.3) frame format:

Preamble	SFD	Destination MAC	Source MAC	Type/Length	Data	FCS
7 bytes	1 byte	6 bytes	6 bytes	2 bytes	46–1500 bytes	4 bytes (CRC)

- **Preamble + SFD:** synchronise the receiver and mark frame start.
- **MAC addresses:** 48-bit hardware addresses.
- **Data:** minimum 46 bytes (padding added) so collisions can be detected; maximum 1500 bytes (MTU).
- **FCS:** CRC-32 for error detection.

Ethernet versions: 10BASE-T (10 Mbps), Fast Ethernet 100BASE-TX, Gigabit 1000BASE-T, 10 GbE over fiber.
