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CUET · COMPUTER SCIENCE · CLASS XII · CODE 308

Computer Networks

CUET unit: Computer Networks

By **UniDrill** · NCERT-grounded study material

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📌 Snapshot

- The foundational vocabulary of computer networking: what a network is, how it evolved from ARPANET to the modern Internet, and how devices are categorised and connected.
- Four network types (PAN, LAN, MAN, WAN) are classified by geographic coverage and data-transfer rate — a frequent CUET discrimination point.
- Network devices (Modem, NIC, RJ45, Repeater, Hub, Switch, Router, Gateway) are explained with distinct roles; CUET regularly tests which device does what.
- Topologies (Mesh, Ring, Bus, Star, Tree/Hybrid) are described with advantages and limitations — a classic MCQ source for both direct recall and scenario-based questions.
- Node identification via MAC address and IP address (IPv4 vs. IPv6), DNS, WWW, HTTP/HTML/URL, and the Internet of Things cover virtually every networking concept tested at the CUET UG level.

📖 Detailed Notes

2.1 Core concepts

- **Definition of network:** A group of two or more similar things or people interconnected with each other is called a network. A computer network is an interconnection among two or more computers or computing devices that allows sharing of data and resources. (NCERT §10.1, p. 182)
- **Node:** In a communication network, each device that is a part of a network and that can receive, create, store or send data to different network routes is called a node. Examples: modem, hub, bridge, switch, router, digital telephone handset, printer, computer, server. (NCERT §10.1, p. 182)
- **Data transmission as packets:** For communication, data in a network is divided into smaller chunks called packets, which are then carried over the network. Devices can be connected through wired media (cables) or wireless media (air). (NCERT §10.1, p. 182)
- **ARPANET and evolution:** In the 1960s, ARPANET was commissioned by the U.S. Department of Defence to connect academic and research institutions. The first message was communicated between UCLA and Stanford Research Institute (SRI). Key milestones: 1961 – ARPANET conceptualised; 1969 – ARPANET became

functional (UCLA–SRI); 1971 – Roy Tomlinson develops e-mail, symbol @ adopted; 1974 – term "Internet" coined, first commercial use of ARPANET under name Telenet; 1982 – TCP/IP introduced as standard protocol on ARPANET; 1983 – Domain Name System introduced; 1986 – NSFNet launched; 1990 – Tim Berners-Lee at CERN developed HTML and URL (birth of WWW); 1997 – first version of Wi-Fi (802.11) standard introduced. (NCERT §10.2, p. 183)

- **Types of networks — PAN:** Personal Area Network; formed by connecting personal devices within an approximate range of 10 metres. Can be wired (USB) or wireless (Bluetooth — called WPAN). (NCERT §10.3.1, p. 184)
- **Types of networks — LAN:** Local Area Network; connects computers and devices at limited distance (single room to a campus). Uses Ethernet cables, fibre optics, or Wi-Fi. Extendable up to 1 km. Data transfer ranges from 10 Mbps (Ethernet) to 1000 Mbps (Gigabit Ethernet). Comparatively secure as only authenticated users can access shared resources. (NCERT §10.3.2, p. 185)
- **Types of networks — MAN:** Metropolitan Area Network; an extended LAN covering a city or town. Data transfer rate is in Mbps but less than LAN. Can be extended up to 30–40 km. Cable TV network and cable-based broadband internet are examples. Multiple LANs connected together can form a MAN. (NCERT §10.3.3, pp. 185-186)
- **Types of networks — WAN:** Wide Area Network; connects computers and other LANs and MANs spread across different geographical locations of a country or different countries or continents. The Internet is the largest WAN, connecting billions of computers and millions of LANs from different continents. (NCERT §10.3.4, p. 186)
- **Modem:** Stands for MOdulator DEModulator. Converts digital data to analog signals (modulation) at the sender end and analog signals back to digital data (demodulation) at the receiver end. Two modems are needed — one at each end. (NCERT §10.4.1, p. 187)
- **Ethernet Card / NIC:** Network Interface Card; a network adapter used to set up a wired network. Acts as an interface between computer and network. Mounted on the motherboard. Supports data transfer between 10 Mbps and 1 Gbps. Each NIC has a unique MAC address that helps identify the computer on the network. (NCERT §10.4.2, p. 188)
- **RJ45:** Registered Jack-45; an eight-pin connector used exclusively with Ethernet cables. A standard networking interface seen at the end of all network cables; fits into RJ-45 jacks of Ethernet cards. (NCERT §10.4.3, p. 188)
- **Repeater:** An analog device that regenerates and amplifies weakened signals on cables. Signals can travel about 100 m before losing strength; the repeater puts the regenerated signal back on the cable. (NCERT §10.4.4, p. 189)
- **Hub:** A network device used to connect different devices through wires. Data arriving on any port is sent out on all other ports (broadcast). Limitation: if data from two devices arrive simultaneously, they collide. (NCERT §10.4.5, p. 189)

- **Switch:** A networking device central to LAN. Unlike a hub, a switch extracts the destination address from the data packet and sends signals only to the selected device. Can forward multiple packets simultaneously. Does not forward noisy or corrupted signals — drops and asks for resend. (NCERT §10.4.6, p. 189)
- **Router:** A network device that can receive data, analyse it and transmit it to other networks. Has advanced capabilities compared to a hub or switch: can decide/alter how data is packaged and can repackage data into smaller packets for a different network type. Can be wired or wireless. Home Wi-Fi routers typically combine router and modem/switch functions. (NCERT §10.4.7, p. 190)
- **Gateway:** A key access point that acts as a "gate" between an organisation's network and the outside Internet. All data coming in or going out must pass through the gateway. Maintains information about the host network's internal paths and identified paths of other remote networks. For simple home Internet, the ISP is usually the gateway. A firewall is usually integrated with the gateway. (NCERT §10.4.8, pp. 190-191)
- **Network topologies — Mesh:** Every device is connected with every other device. Handles large traffic; highly reliable (node failure does not break other transmissions); more secure (each cable carries different data). Disadvantage: complex wiring, high cabling cost, many redundant connections. For n nodes, fully-connected mesh requires n(n-1)/2 wires. (NCERT §10.5.1, p. 192)
- **Network topologies — Ring:** Each node is connected to exactly two other devices, one on each side, forming a ring. Data transmission is unidirectional (clockwise or counterclockwise only). Considered less secure and less reliable. (NCERT §10.5.2, p. 192)
- **Network topologies — Bus:** All devices connect to a single backbone wire called the bus. Data sent from any node travels in both directions along the bus and can be received by any node. Single shared backbone makes it cheaper and easier to maintain. Less secure and less reliable than mesh. (NCERT §10.5.3, pp. 192-193)
- **Network topologies — Star:** Each device is connected to a central node (hub or switch). Very effective, efficient and fast. Failure of one device does not affect the rest, but failure of the central node causes complete network failure. Central node can be broadcasting (sends to all) or unicast (identifies destination and forwards only there). (NCERT §10.5.4, p. 193)
- **Network topologies — Tree/Hybrid:** A hierarchical topology with multiple branches; each branch can have one or more basic topologies (star, ring, bus). Usually realised in WANs where multiple LANs are connected. Data from source first reaches the centralised device and then passes through every branch. (NCERT §10.5.5, p. 193)
- **MAC Address:** Media Access Control address; also called the physical or hardware address. A unique 12-digit hexadecimal number (48 bits) engraved on the NIC at manufacture — permanent and cannot be changed. First 6 digits (24 bits) =

Organisational Unique Identifier (OUI — manufacturer ID); last 6 digits (24 bits) = unique serial number assigned by manufacturer. Example: FC:F8:AE:CE:7B:16. (NCERT §10.6.1, p. 194)

- **IP Address:** Internet Protocol address; a unique address used to identify each node in a network that uses the Internet Protocol. Unlike MAC address, IP address can change when a node moves to a different network. IPv4: 32-bit address, written as four decimal numbers (0–255) separated by periods. Example: 192.168.0.178. IPv4 supports ~4.3 billion unique addresses. IPv6: 128-bit address, represented as eight groups of hexadecimal numbers separated by colons. Example: 2001:CDBA:0000:0000:0000:0000:3257:9652. (NCERT §10.6.2, pp. 194-195)
- **Internet, WWW, IoT:** The Internet is the global network of computing devices. The WWW is an ocean of information stored in trillions of interlinked web pages accessible over the Internet — invented by Tim Berners-Lee in 1990 through three technologies: HTML, URI/URL, and HTTP. HTTP (HyperText Transfer Protocol) retrieves linked web pages; HTTPS is the more secure version. The Internet is also used by smart devices (TV, AC, refrigerator, drones, vehicles, door locks) — collectively called Internet of Things (IoT). (NCERT §10.7 and §10.7.1, pp. 195-196)
- **DNS and DNS Server:** Domain Name System maps human-readable domain names (hostnames) to IP addresses. The process of converting a domain name to its IP address is called domain name resolution, performed by a DNS server. DNS servers are arranged in hierarchical order; at the top are 13 root servers (named A–M). IANA (Internet Assigned Numbers Authority) maintains the list of DNS root servers. (NCERT §10.8 and §10.8.1, pp. 197-198)

2.2 Definitions to memorise

Term	Definition	Page
Computer Network	An interconnection among two or more computers or computing devices that allows sharing of data and resources	182
Node	Any device in a communication network that can receive, create, store or send data to different network routes	182
Packet	A smaller chunk into which data is divided for transmission across a network	182
PAN	Personal Area Network; connects personal devices within ~10 metres range	184
LAN	Local Area Network; connects devices within a limited area (room to campus); extends up to 1 km	185
MAN	Metropolitan Area Network; covers a city or town; extends up to 30–40 km	185
WAN		186

Term	Definition	Page
	Wide Area Network; connects LANs and MANs across countries or continents	
Ethernet	A set of rules that decides how computers and devices connect with each other through cables in a LAN	185
Modem	MOdulator DEModulator; converts digital data to analog signals and vice versa	187
NIC	Network Interface Card; a network adapter used to set up a wired network; has a unique MAC address	188
RJ45	Registered Jack-45; eight-pin connector used exclusively with Ethernet cables	188
Repeater	Analog device that regenerates and amplifies weakened signals on cables	189
Hub	Network device that broadcasts data arriving on any port to all other ports	189
Switch	Network device that sends data only to the specific destination device using address lookup	189
Router	Network device that receives, analyses and transmits data to other networks; can repackage packets	190
Gateway	Key access point acting as entry and exit point between an organisation's network and the Internet	190
Topology	The arrangement of computers and other peripherals in a network	191
MAC Address	12-digit (48-bit) hexadecimal hardware address engraved on NIC at manufacture; permanent and unique	194
IPv4	32-bit IP address written as four decimal numbers (0–255) separated by periods; ~4.3 billion addresses	194
IPv6	128-bit IP address represented as eight hexadecimal groups separated by colons	195
WWW	World Wide Web; ocean of information stored in trillions of interlinked web pages accessible over the Internet	196
HTML	HyperText Markup Language; language used to design standardised web pages	196
URL/URI	Uniform Resource Locator/Identifier; unique address for each resource on the web	196
HTTP	HyperText Transfer Protocol; set of rules to retrieve linked web pages; HTTPS is its secure version	196
DNS	Domain Name System; maps domain names (hostnames) to IP addresses	197

Term	Definition	Page
Domain Name Resolution	Conversion of a domain name to its corresponding IP address; done by a DNS server	198
ISP	Internet Service Provider; any organisation that provides services for accessing the Internet	189
ARPANET	Advanced Research Projects Agency Network; precursor to the Internet, commissioned by U.S. Dept. of Defence	183
Mesh Topology	Every node connected to every other; requires n(n-1)/2 links	192
Ring Topology	Each node connected to exactly two neighbours forming a closed loop	192
Bus Topology	All nodes share a single linear backbone wire	192-193
Star Topology	Each node connected to a central hub or switch	193
Tree/Hybrid Topology	Hierarchical mix of multiple topologies	193
Bluetooth (WPAN)	Short-range wireless personal area network technology	184
Wi-Fi 802.11	First wireless LAN standard (1997)	183
TCP/IP	Standard transport/network protocols since 1982	183
HTTPS	Secure HTTP using SSL/TLS	196
Firewall	Security software/hardware typically integrated with the gateway	191
OUI (Organisational Unique Identifier)	First 24 bits of a MAC address identifying the manufacturer	194
Octet	An 8-bit group of an IPv4 address (0-255)	195
Tim Berners-Lee	Inventor of the World Wide Web (1990) at CERN	196

2.3 Diagrams / processes to remember

- **Figure 10.2 (p. 182):** A computer network — shows a networking device at the centre connecting a desktop, laptop, tablet/phone, and printer. Demonstrates that a basic network requires a central networking device connecting diverse nodes.
- **Figure 10.3 (p. 183):** Timeline of networking evolution (1961–1997) — key dates: 1969 ARPANET functional, 1971 e-mail invented, 1982 TCP/IP standard, 1983 DNS introduced, 1990 WWW born, 1997 Wi-Fi 802.11. Frequently tested as a timeline matching question.
- **Figure 10.8 (p. 188):** Use of modem — shows digital signal → modulation → analog signal over telephone line → demodulation → digital signal. The sender-side modem acts as modulator; receiver-side modem acts as demodulator.

- **Figure 10.14 (p. 191):** Network gateway — two separate networks (10.0.0.0/8 and 20.0.0.0/8) connected through a single gateway device. All inter-network data must pass through the gateway.
- **Figures 10.15–10.19 (pp. 192–194):** Five topology diagrams — Mesh (every node connected to every other), Ring (circular chain), Bus (linear backbone), Star (central hub/switch), Hybrid/Tree (4-star topologies on a bus). Sketch these for quick recall.
- **Figure 10.20 (p. 198):** DNS resolution — browser sends domain name (www.ncert.nic.in) to DNS server, which returns IP address (164.100.60.233). Illustrates domain name resolution process.
- **MAC address structure (p. 194):** FC:F8:AE:CE:7B:16 — first three octets (FC:F8:AE) = OUI (manufacturer); last three octets (CE:7B:16) = unique serial number.

2.4 Common confusions / NTA trap points

- **Hub vs. Switch:** Hub broadcasts to all ports (causes collisions if two devices send simultaneously); Switch reads destination address and sends only to that device. NTA often uses a scenario asking which device is "smarter" or "more efficient" — the answer is always Switch.
- **MAC address vs. IP address:** MAC is permanent, hardware-level, 48-bit hexadecimal, engraved at manufacture, cannot change. IP is logical, software-level, can change when device moves to a different network. Students often confuse "which can be changed" — only IP address can change.
- **Internet vs. WWW:** The Internet is the global network infrastructure (hardware + protocols). WWW is a service/application that runs on the Internet — a collection of interlinked web pages. Many students treat them as synonyms; NTA tests this distinction directly.
- **Router vs. Gateway:** A router connects a LAN to the Internet; a gateway is the entry/exit point of a network and all data must pass through it. In practice, a router is often configured as a gateway, but they are conceptually distinct. NTA may ask which device "routes data to other networks" (Router) vs. which "controls all incoming and outgoing data" (Gateway).
- **IPv4 address range (NCERT §10.6.2, pp. 194-195).** Each octet is 8-bit (0-255). Values above 255 in distractor options are wrong. IPv4 = 32-bit; IPv6 = 128-bit.
- **HTTP is not HTTPS (NCERT §10.7.1, p. 196).** HTTPS is the secure (SSL/TLS) version of HTTP.
- **DNS root servers count = 13 (A-M) (NCERT §10.8.1, p. 198).** NTA may give 16 or 12 as distractors.
- **NIC has both wired and wireless variants.** Ethernet (wired) NICs have RJ-45 jacks; Wi-Fi cards are wireless NICs.
- **The first message via ARPANET was UCLA-SRI (NCERT §10.2, p. 183).** Not UCLA-MIT or UCLA-CERN.

- **A repeater is analog (NCERT §10.4.4, p. 189).** It regenerates and amplifies; not the same as a router or switch.
- **Star topology fails if central node fails (NCERT §10.5.4, p. 193).** Single point of failure.

🎯 Practice MCQs

Q1. Which of the following network devices sends data only to the specific destination device by reading the destination address from the data packet?

A. Hub

B. Repeater

C. Switch

D. Modem

Q2. A fully-connected mesh topology network has 6 nodes. How many wires are required to connect all nodes?

A. 12

B. 15

C. 18

D. 30

Q3. Consider the following statements about MAC address: 1. MAC address is a 12-digit hexadecimal number of 48 bits. 2. The first six digits represent the serial number assigned by the manufacturer. 3. MAC address is engraved on the NIC at the time of manufacturing. 4. MAC address can change when a device moves to a different network. Which of the above statements are correct?

A. 1 and 3 only

B. 1, 3 and 4 only

C. 2 and 4 only

D. 1, 2 and 3 only

PYQ Alignment

Computer networks appear consistently in CUET Computer Science papers, with questions distributed across network types (PAN/LAN/MAN/WAN distinctions), network device functions (especially hub vs. switch vs. router), topology identification from descriptions or diagrams, and node addressing (MAC vs. IP address properties). DNS, HTTP, and the Internet vs. WWW distinction have also featured as direct factual or assertion-reason questions in recent years. See PYQ archive for Computer Science.