### ****1. OSI vs TCP/IP Models****

(Already covered above, kept here for completeness)

#### ****OSI Model**** (7 Layers)

1. **Physical Layer** – Raw bit transmission, cables, voltages, physical connectors.
2. **Data Link Layer** – Error detection/correction, MAC addressing, framing.
3. **Network Layer** – Logical addressing, routing (IP).
4. **Transport Layer** – End-to-end delivery, segmentation, error control (TCP, UDP).
5. **Session Layer** – Establish, maintain, terminate communication sessions.
6. **Presentation Layer** – Data translation, encryption, compression.
7. **Application Layer** – User-facing services (HTTP, SMTP, FTP).

#### ****TCP/IP Model**** (4 Layers)

1. **Network Interface** – Physical & data link functions.
2. **Internet** – IP addressing, routing.
3. **Transport** – TCP, UDP.
4. **Application** – All application-level protocols.

### ****2. Routing Algorithms****

* **Distance Vector Routing (Bellman-Ford)**
* **Link-State Routing (Dijkstra)**
* **Hybrid protocols**: EIGRP.
* **Path Vector Protocol**: BGP (Border Gateway Protocol) for internet-scale routing.

### ****3. Common Protocols****

* **TCP** – Reliable, ordered, error-checked.
* **UDP** – Faster, connectionless, no guarantee.
* **HTTP/HTTPS** – Web communication (HTTPS is HTTP over TLS).
* **FTP/SFTP** – File transfer protocols.
* **SMTP, POP3, IMAP** – Email protocols.
* **DNS** – Domain name resolution.
* **DHCP** – Dynamic IP allocation.
* **SNMP** – Network management.
* **ICMP** – Error messages (ping, traceroute).

### ****4. Network Devices****

* **Switch** – Layer 2, connects LAN devices using MAC addresses.
* **Router** – Layer 3, connects different networks using IP.
* **Gateway** – Protocol converter between dissimilar networks.
* **Hub** – Simple device, broadcasts to all ports (obsolete in modern networks).
* **Access Point (AP)** – Wireless connectivity.
* **Firewall** – Security filtering.
* **Load Balancer** – Distributes network traffic.

### ****5. Network Topologies****

Network topology refers to how devices are arranged and connected.

1. **Bus Topology**
   * All devices connected to a single backbone cable.
   * Pros: Cheap, easy to set up.
   * Cons: Single point of failure, collisions.
2. **Star Topology**
   * Devices connected to a central hub/switch.
   * Pros: Easy to manage, one link failure doesn't affect others.
   * Cons: Hub failure stops entire network.
3. **Ring Topology**
   * Devices connected in a closed loop.
   * Pros: Equal access, predictable performance.
   * Cons: One failure affects the whole network.
4. **Mesh Topology**
   * Every device connected to every other.
   * Pros: High redundancy, fault tolerance.
   * Cons: Expensive, complex.
5. **Hybrid Topology**
   * Combination of multiple topologies.
6. **Tree Topology**
   * Hierarchical arrangement (root switch → branches).

### ****6. Transmission Media****

**Wired:**

* **Twisted Pair Cable** (UTP/STP) – Ethernet networks.
* **Coaxial Cable** – TV, broadband internet.
* **Optical Fiber** – High-speed, long-distance communication.

**Wireless:**

* **Radio Waves** – Wi-Fi, Bluetooth.
* **Microwaves** – Satellite links, point-to-point communication.
* **Infrared** – Short-range device communication.

### ****7. Types of Networks****

* **PAN** (Personal Area Network) – Very small range (Bluetooth).
* **LAN** (Local Area Network) – Small geographical area (office, home).
* **MAN** (Metropolitan Area Network) – City-wide.
* **WAN** (Wide Area Network) – Country/worldwide (Internet).
* **VPN** (Virtual Private Network) – Secure private connection over public networks.

### ****8. Switching Techniques****

* **Circuit Switching** – Dedicated path for the entire communication (like telephone calls).
* **Packet Switching** – Data divided into packets (used in the Internet).
* **Message Switching** – Store-and-forward entire messages (obsolete).

### ****9. Error Detection & Correction****

* **Parity Check** – Simple single-bit error detection.
* **Checksum** – Detects errors in transmitted data.
* **CRC (Cyclic Redundancy Check)** – Stronger detection for frames.
* **Hamming Code** – Error detection & correction.

### ****10. Multiplexing Techniques****

* **TDM (Time Division Multiplexing)** – Time slots for each signal.
* **FDM (Frequency Division Multiplexing)** – Different frequency bands.
* **WDM (Wavelength Division Multiplexing)** – Optical fiber-based.

### ****11. Network Security Concepts****

* **Firewalls** – Block unauthorized access.
* **Encryption** – Securing data (AES, RSA).
* **VPNs** – Encrypted tunneling.
* **IDS/IPS** – Intrusion detection/prevention.
* **Authentication** – Verifying identity (passwords, biometrics).
* **Access Control Lists (ACLs)** – Restrict network traffic.

### ****12. Cloud & Modern Networking****

* **SDN (Software Defined Networking)** – Network control via software.
* **NFV (Network Functions Virtualization)** – Virtualized network services.
* **IoT Networking** – Connecting smart devices.
* **5G Networks** – High-speed, low-latency mobile communication.

### ****13. Important Networking Commands****

* ping – Test connectivity.
* traceroute / tracert – Show path packets take.
* ipconfig / ifconfig – Display network settings.
* netstat – Show active connections.
* nslookup / dig – DNS queries.