COMPUTER NETWORKS - PRACTICAL & VIVA COMPLETE NOTES

1. INTRODUCTION

- Computer Network: collection of interconnected devices that share resources and exchange data.
- Common benefits: resource sharing, communication, centralized data, cost efficiency.
- Network types: LAN, MAN, WAN.

2. NETWORK DEVICES (WHAT & WHY)

- HUB: Layer 1, broadcasts incoming frames to all ports. Simple, causes collisions.
- SWITCH: Layer 2, uses MAC table to forward frames only to destination port. Reduces collisions.
- ROUTER: Layer 3, forwards packets between different IP networks using routing tables.
- BRIDGE: Connects two LAN segments, operates at Data Link.
- GATEWAY: Connects networks with different protocols (can operate up to application layer).
- ACCESS POINT (AP): Wireless bridge between Wi-Fi devices and wired LAN.
- MODEM: Modulator-demodulator: converts digital<->analog for telephone lines.
- FIREWALL: Filters traffic based on rules, can be hardware/software.

3. NETWORK TOPOLOGIES

- Physical vs Logical topology.
- Bus: single backbone cable. Terminators at ends. Single failure affects whole network.
- Star: central switch/hub. Easy expansion, single point of failure is central device.
- Ring: each node connected to two others; data circulates. Token ring concept.
- Mesh: every node connected to every other node. High redundancy, costly.
- Hybrid: combination of above.
- Use Packet Tracer to draw and test these.

4. TRANSMISSION MEDIA

- Wired: Twisted Pair (CAT5/CAT6), Coaxial, Fiber Optic.
- Wireless: Wi-Fi (802.11), Bluetooth, Infrared, Cellular.
- Characteristics: bandwidth, attenuation, interference, cost.

5. OSI MODEL - 7 LAYERS (ONE-LINER)

7 Application: user-level services (HTTP, FTP, DNS).

6 Presentation: data formatting, encryption, compression.

5 Session: manages sessions (start/stop).

4 Transport: end-to-end delivery (TCP/UDP).

3 Network: routing, IP addressing.

2 Data Link: MAC addressing, framing.

1 Physical: bits, media, connectors.

6. IP ADDRESSING BASICS

- IPv4: 32-bit address, 4 octets (0-255).
- Classes:
  A: 1.0.0.0 - 126.255.255.255 (/8)
  B: 128.0.0.0 - 191.255.255.255 (/16)
  C: 192.0.0.0 - 223.255.255.255 (/24)
  D: 224-239 multicast
  E: 240-255 experimental
- Special: 127.0.0.1 loopback, 169.254.x.x APIPA, private ranges:
  10.0.0.0/8, 172.16.0.0 - 172.31.255.255, 192.168.0.0/16

7. SUBNETTING & CIDR

- CIDR: Classless Inter-Domain Routing. Notation: 192.168.1.0/24
- Host bits = 32 - prefix. Usable hosts = 2^(host_bits) - 2
- Examples:
  /24 -> host bits 8 -> 256 total -> 254 usable
  /26 -> host bits 6 -> 64 total -> 62 usable
  /30 -> host bits 2 -> 4 total -> 2 usable (point-to-point)
- Example: need 300 hosts -> need 302 addresses -> 2^9=512 -> host bits=9 -> prefix=32-9=23 -> /23 mask 255.255.254.0
- Subnetting steps: choose prefix, calculate mask, network id, broadcast, first/last usable.

8. CIDR CALCULATION QUICK STEPS

- Given /prefix: mask in binary has prefix ones then zeros.
- Convert each 8-bit block to decimal to get dotted mask.
- Block size = 256 - mask_octet at the first non-255 octet.
- Subnet ranges increment by block size in that octet.

9. PING and BASIC TROUBLESHOOTING

- ping <ip/hostname>: sends ICMP echo requests, measures RTT.
- Common outputs: reply, request timed out, destination host unreachable.
- Use ipconfig / ifconfig to view local IP, arp -a to see MAC-IP mapping, tracert/traceroute to see path.

10. DNS - DOMAIN NAME SYSTEM

- Purpose: map human-readable names to IPs and vice versa.
- Forward lookup: domain -> A (IPv4) or AAAA (IPv6) records.
- Reverse lookup: IP -> PTR record in in-addr.arpa or ip6.arpa.
- DNS hierarchy: root -> TLD -> authoritative nameservers -> recursive resolver.
- Typical tools: nslookup, dig.
- Python: socket.gethostbyname(host) returns IPv4; gethostbyaddr(ip) returns (hostname, aliases, addrs).
- C++ legacy: gethostbyname, gethostbyaddr; modern: getaddrinfo/getnameinfo.

11. SOCKET PROGRAMMING - TCP (CONCEPT & CODE)
- TCP is connection-oriented, reliable, stream-based, full-duplex.
- Server steps (Java/C++): socket(), bind(), listen(), accept(), read/write, close()
- Client steps: socket(), connect(), write/read, close()
- Java classes: ServerSocket, Socket, InputStreamReader/BufferedReader, PrintWriter.
- C++: socket(), bind(), listen(), accept(), send()/recv() or read()/write().
- Two-way chat: both sides maintain input and output streams and loop until exit.
- Blocking calls: accept() and readLine()/recv() block until data arrives. Use threads or non-blocking I/O for multi-client servers.
- TCP handshake: SYN, SYN-ACK, ACK.

12. UDP - QUICK NOTES
- UDP is connectionless, datagram-based, low overhead, no guarantee of delivery or ordering.
- Useful for streaming, DNS queries, VoIP, gaming.
- Java: DatagramSocket and DatagramPacket.
- C++: sendto()/recvfrom().

13. PACKET TRACER PRACTICALS (SUMMARY)
- How to simulate topologies: place devices, connect with cables, assign IPs, test with ping.
- For bus topology, simulate linear connections; for star use switch; for mesh connect all pairs.
- Practical 3: configure 3 routers with routing protocol (RIP/OSPF/BGP):
  - RIP: router rip; version 2; network <network>
  - OSPF: router ospf <id>; network <net> <wildcard> area <area>
  - Verify: show ip route, ping between hosts.

14. ORAL/VIVA PREP - COMMON QUESTIONS & SHORT ANSWERS
- What is a socket? -> Software endpoint for network communication (IP+port).
- Difference IP vs MAC? -> IP is logical network-layer address; MAC is physical data-link address.
- What does ARP do? -> Resolves IP -> MAC in same LAN.

- What is NAT? -> Network Address Translation; maps private IPs to public IPs on router.
- What is DHCP? -> Dynamic Host Configuration Protocol; assigns IPs automatically.
- What is a gateway? -> Router interface that forwards traffic outside the local network.
- Why run server first? -> Server must be listening before client connects.
- What is loopback address? -> 127.0.0.1 used to test TCP/IP stack locally.

15. EXAM TIPS & PRACTICAL CHECKLIST
- Always verify IP configuration with ipconfig/ifconfig before testing.
- Use correct subnet mask; wrong mask causes unreachable host errors.
- Start server before client; use correct port and localhost vs actual IP for LAN tests.
- For Packet Tracer: save .pkt file, label devices and interfaces, document IP addresses used.

16. REFERENCE COMMANDS
- Windows: ipconfig, ping, tracert, nslookup, arp -a
- Linux: ifconfig or ip addr, ping, traceroute, dig, arp

17. IMPORTANT FORMULAS
- Total addresses in subnet = 2^(32 - prefix)
- Usable hosts = 2^(32 - prefix) - 2
- Prefix from hosts needed: find smallest n s.t. 2^n - 2 >= required hosts, then prefix = 32 - n.

End of notes.