Data Communication and Computer Networks: Selected Answers

1. (a) OSI Model as Open System, Layered Model Preference, OSI vs TCP/IP

Why is the OSI model considered an Open System?
The OSI (Open Systems Interconnection) model is considered "open" because it provides a standardized framework that allows diverse systems from different manufacturers to communicate with each other by following common protocols and standards.

Why is a multilayer reference model preferred over a single-layer structure?

- Modularity: Each layer can be developed, tested, and updated independently.
- Simplicity: Troubleshooting and understanding the network is easier.
- Interoperability: Devices and software from different vendors can work together.
- Flexibility: Changes in one layer don’t require changes in others.

Comparison: OSI vs TCP/IP

Aspect	**OSI Model**	**TCP/IP Model**
Layers	7	4
Development	ISO (International)	DoD (U.S. Department)
Specification	Reference, theoretical	Actual protocols in use
Service/Interface	Strict separation	More flexible

Example layers	Application, Presentation, etc.	Application, Transport, etc.

1. (b) Optical Fiber vs Twisted-Pair and Coaxial

Advantages of Optical Fiber:

1. Higher Bandwidth: Supports much higher data rates.
2. Lower Signal Loss: Signals travel longer distances without significant attenuation.
3. Immunity to Electromagnetic Interference: Not affected by external electrical noise.
4. Security: Hard to tap without detection.
5. Lightweight and Thin: Easier to handle and install.

1. (c) Bridge vs Router, Switch vs Hub

Bridge vs Router:

Feature	**Bridge**	**Router**
OSI Layer	Data Link (Layer 2)	Network (Layer 3)
Function	Connects LAN segments	Connects different networks (LAN/WAN)
Address Used	MAC address	IP address
Speed	Faster	Slower (due to routing decisions)

Why is a switch preferred over a hub?

- Switch sends frames only to the intended host (reducing collisions).
- Handles data based on MAC addresses; improves security and speed.
- Hub broadcasts data to all devices, causing unnecessary network traffic and more collisions.

2. (a) Crossbar Switch & Multistage Importance

Crossbar Switch:
A matrix network that connects multiple inputs to multiple outputs using switches at intersection points.

Importance of Multistage Crossbar Switches:

- Reduces the number of crosspoints compared to a single stage, lowering cost and complexity.
- Example: The Clos network uses multiple stages for scalability.

2. (b) Circuit-Switched vs Packet-Switched Networks

Aspect	**Circuit-Switched Network**	**Packet-Switched Network**
Path	Dedicated path per session	Data split into packets, dynamic path
Setup Time	Required before communication	Not required

Efficiency	Low (idle path if unused)	High, resources shared
Example	Telephone systems	Internet

2. (c) Packet Switch Components and Application

Major Components and Functions:

1. Input Port: Receives packets.
2. Switching Fabric: Transfers packets from input to output port.
3. Output Port: Delivers packets to destination line.
4. Routing Processor: Determines forwarding path.

Application:
Routers in the Internet use packet switching for efficient, scalable data transfer.

3. (a) Pure ALOHA vs Slotted ALOHA

Aspect	**Pure ALOHA**	**Slotted ALOHA**
Time Slots	No	Yes (fixed time slots)
Max. Throughput	18%	37%
Efficiency	Lower	Higher

Collision	More likely	Reduced by time division

3. (b) Error Correction and Detection

Forward Error Correction (FEC):
Errors are detected and corrected by the receiver, using redundant information.

Error Correction by Retransmission (ARQ):
Only detects errors. A request is sent for retransmission of the erroneous data.

Single-bit vs Burst Error:

- Single-bit: Only one bit changes.
- Burst: Two or more consecutive bits change.

Undetectable Error:
Occurs if the erroneous bit sequence is still a valid codeword (checksum/coding limitations).

3. (c) Go-Back-N ARQ vs Selective Repeat ARQ

Aspect	**Go-Back-N ARQ**	**Selective Repeat ARQ**
Retransmission	All frames after error	Only the erroneous frames
Bandwidth Use	Less efficient	More efficient

Complexity	Simpler	More complex

4. (a) Non-persistent vs 1-persistent CSMA

Non-persistent CSMA:
Waits random time if channel busy, reducing collisions.

1-persistent CSMA:
Transmits as soon as channel is idle, causing higher chance of collision in congested networks.

CSMA/CD:
Stops transmission after detecting a collision; waits random time before retrying, reducing repeated collisions.

4. (b) IPv6 Advantages Over IPv4

- Larger Address Space: 128-bit vs 32-bit.
- Simplified Headers: Improves processing speed.
- Better Security: IPsec is mandatory.
- Auto-configuration: Simplifies network management.
- No NAT Needed: End-to-end connectivity.

4. (c) Dynamic vs Static Mapping, ARP vs RARP

Dynamic Mapping:
Automatic, adapts to changes (e.g. ARP finds MAC address for a given IP dynamically).

Static Mapping:

Manually configured; doesn't adapt to changes.

ARP: Maps IP address to MAC address.
RARP: Maps MAC address to IP address.

5. (a) Steps in Link-State Routing Algorithm

1. Discover and identify neighbors.
2. Measure cost or delay to each neighbor.
3. Build link-state packets (LSP).
4. Flood LSPs throughout the network.
5. Each router builds a complete network map.
6. Use Dijkstra's algorithm to calculate shortest paths.

Example: OSPF protocol in large IP networks.

5. (b) Congestion Control vs QoS; Open vs Closed-Loop Congestion Control

Relation:
Congestion negatively affects QoS parameters (latency, jitter, packet loss). Effective congestion control improves QoS.

Aspect	**Open-loop**	**Closed-loop**
Feedback	No	Yes
Type	Preventive	Reactive
Example	Traffic shaping	TCP congestion control

5. (c) Leaky Bucket Algorithm for QoS

- Concept: Fixed-size bucket leaks data at a constant rate.
- Function: Smoothens bursty traffic, prevents buffer overflow.
- Benefit: Guarantees steady output, regulates network traffic, minimises packet loss.
- QoS Improvement: Ensures fair and predictable use of network resources.