

# Computer Networking (4343202) - Summer 2025 Solution

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## Question 1(a) [3 marks]

List Various network Topologies of computer network and explain any one.

### Solution

**Table 1.** Network Topologies

Topology	Description
Star	Central hub connects all devices
Ring	Devices connected in circular chain
Bus	Single cable backbone connection
Mesh	Every device connects to every other
Tree	Hierarchical branching structure
Hybrid	Combination of multiple topologies

#### Star Topology Explanation:

- **Central Hub:** All devices connect to one central point
- **Easy Installation:** Simple to add/remove devices
- **Single Point Failure:** Hub failure affects entire network

### Mnemonic

“SRBMTH - Star Ring Bus Mesh Tree Hybrid”

## Question 1(b) [4 marks]

Compare LAN, WAN and MAN.

### Solution

**Table 2.** LAN vs MAN vs WAN

Parameter	LAN	MAN	WAN
Coverage	Building/Campus	City/Metropolitan	Country/Global
Speed	Very High (1-100 Gbps)	High (10-100 Mbps)	Medium (1-100 Mbps)
Cost	Low	Medium	High
Ownership	Private	Public/Private	Public

#### Key Points:

- **LAN:** Local Area Network for small areas
- **MAN:** Metropolitan Area Network for cities

- **WAN:** Wide Area Network for large distances

### Mnemonic

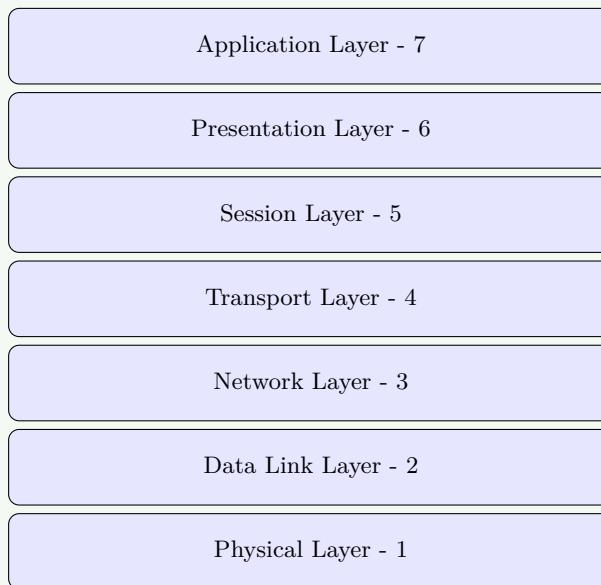
“LMW - Local Metropolitan Wide”

## Question 1(c) [7 marks]

Draw the layered architecture of OSI reference model and write at least two services provided by each layer of the model.

### Solution

#### OSI Model Architecture:



**Figure 1.** OSI Reference Model

**Table 3.** OSI Layer Services

Layer	Services
Application (7)	Email services, File transfer
Presentation (6)	Data encryption, Data compression
Session (5)	Session establishment, Session termination
Transport (4)	Flow control, Error correction
Network (3)	Routing, Path determination
Data Link (2)	Frame synchronization, Error detection
Physical (1)	Bit transmission, Signal conversion

### Mnemonic

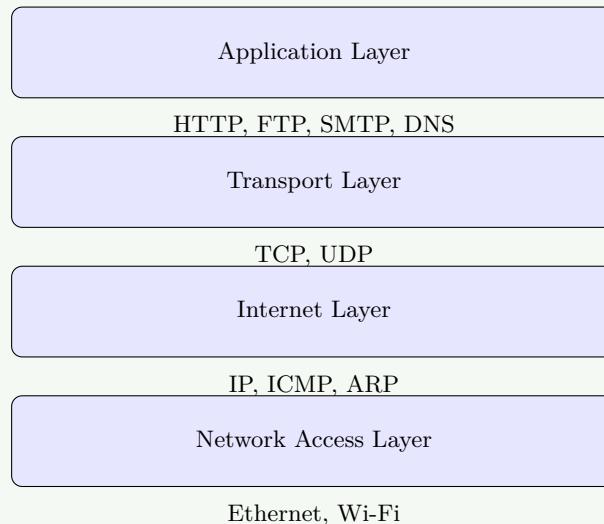
“All People Seem To Need Data Processing”

## Question 1(c OR) [7 marks]

Explain Each layer of TCP/IP Model with its protocol.

### Solution

#### TCP/IP Model Layers:



**Figure 2.** TCP/IP Model

**Table 4.** TCP/IP Layer Details

Layer	Protocols	Function
Application	HTTP, FTP, SMTP, DNS	User applications
Transport	TCP, UDP	End-to-end delivery
Internet	IP, ICMP, ARP	Routing packets
Network Access	Ethernet, Wi-Fi	Physical transmission

#### Key Features:

- **Simplified Model:** Only 4 layers vs OSI's 7
- **Protocol Suite:** Complete networking solution
- **Internet Standard:** Basis of modern internet

### Mnemonic

“ATIN - Application Transport Internet Network”

## Question 2(a) [3 marks]

Explain functions of following network devices: Repeater, Hub

### Solution

**Table 5.** Network Device Functions

Device	Function	Layer
Repeater	Signal amplification, Range extension	Physical (1)
Hub	Signal broadcasting, Collision domain sharing	Physical (1)

**Details:**

- **Repeater:** Regenerates weak signals over long distances
- **Hub:** Connects multiple devices in star topology
- **Shared Medium:** Both create single collision domain

**Mnemonic**

“RH - Repeat Hub signals”

**Question 2(b) [4 marks]**

Explain the following term 1) FDDI 2) ARP, RARP

**Solution****FDDI (Fiber Distributed Data Interface):**

- **Technology:** 100 Mbps fiber optic network
- **Topology:** Dual ring for fault tolerance
- **Application:** Backbone networks, high reliability

**ARP (Address Resolution Protocol):**

- **Function:** Maps IP address to MAC address
- **Process:** Broadcasts request, receives reply

**RARP (Reverse ARP):**

- **Function:** Maps MAC address to IP address
- **Usage:** Diskless workstations, boot process

**Mnemonic**

“FAR - FDDI ARP RARP”

**Question 2(c) [7 marks]**

Explain the Function of firewall in network security with principles and Kerberos-concept.

**Solution****Firewall Principles:**

- **Packet Filtering:** Examines packet headers
- **Stateful Inspection:** Tracks connection states
- **Application Gateway:** Deep packet inspection



Blocks Threats  
Allows Safe Traffic

**Figure 3.** Firewall Function

**Kerberos Concept:**



Figure 4. Kerberos Authentication

- **Authentication Service:** Secure user verification
- **Ticket System:** Time-limited access tokens
- **Three-party Protocol:** Client, Server, Key Distribution Center

#### Security Benefits:

- **Access Control:** Prevents unauthorized access
- **Network Protection:** Shields internal resources

#### Mnemonic

“FPK - Firewall Protects with Kerberos”

## Question 3(a) [3 marks]

Find the class of following IP address.

- 1) 01111000 00001111 10101010 11000000
- 2) 11101000 01010101 11111111 11000011

#### Solution

##### IP Address Classification:

Table 6. IP Class Analysis

Binary Address	Decimal	First Octet	Class
01111000...	120.15.170.192	120 (64-127)	Class A
11101000...	232.85.255.195	232 (224-239)	Class D

##### Class Ranges:

- **Class A:** 1-126 (0xxxxxxx)
- **Class B:** 128-191 (10xxxxxx)
- **Class C:** 192-223 (110xxxxx)
- **Class D:** 224-239 (1110xxxx)

##### Results:

- **First IP:** Class A (Unicast)
- **Second IP:** Class D (Multicast)

#### Mnemonic

“ABCD - A(1-126) B(128-191) C(192-223) D(224-239)”

## Question 3(b) [4 marks]

Differentiate IPv4 and IPv6.

#### Solution

##### IPv4 vs IPv6 Comparison:

Table 7. IPv4 vs IPv6

Feature	IPv4	IPv6
<b>Address Length</b>	32 bits	128 bits
<b>Address Format</b>	Dotted decimal	Hexadecimal
<b>Address Space</b>	4.3 billion	340 undecillion
<b>Header Size</b>	Variable (20-60 bytes)	Fixed (40 bytes)
<b>Security</b>	Optional (IPSec)	Built-in (IPSec)
<b>Configuration</b>	Manual/DHCP	Auto-configuration

**Key Differences:**

- **Addressing:** IPv6 provides vastly more addresses
- **Security:** IPv6 has mandatory security features
- **Performance:** IPv6 has simplified header structure

**Mnemonic**

“IPv4 to IPv6 = More addresses, Better security”

**Question 3(c) [7 marks]**

Explain Static and Dynamic Routing Algorithms.

**Solution****Static Routing:****Dynamic Routing:**

**Figure 5.** Static vs Dynamic Routing

**Comparison Table:**

**Table 8.** Static vs Dynamic Routing

Aspect	Static Routing	Dynamic Routing
<b>Configuration</b>	Manual setup	Automatic discovery
<b>Adaptability</b>	No adaptation	Adapts to changes
<b>Resource Usage</b>	Low CPU/Memory	Higher CPU/Memory
<b>Scalability</b>	Poor for large networks	Good for large networks
<b>Protocols</b>	None required	RIP, OSPF, BGP

**Applications:**

- **Static:** Small networks, specific paths
- **Dynamic:** Large networks, fault tolerance

**Mnemonic**

“SD - Static=Simple, Dynamic=Automatic”

## Question 3(a OR) [3 marks]

Explain CIDR. How does it differ from traditional IP address allocation methods?

### Solution

**CIDR (Classless Inter-Domain Routing):**

- **Concept:** Variable length subnet masking
- **Notation:** IP address/prefix length (e.g., 192.168.1.0/24)
- **Flexibility:** Subnets of any size

**Traditional vs CIDR:**

Table 9. Traditional vs CIDR

Method	Allocation	Efficiency
Traditional	Fixed class boundaries	Wasteful (Class B = 65,536 IPs)
CIDR	Variable subnet sizes	Efficient allocation

**Benefits:**

- **Address Conservation:** Reduces IP address waste
- **Route Aggregation:** Summarizes multiple routes

### Mnemonic

“CIDR = Classless Intelligent Address Routing”

## Question 3(b OR) [4 marks]

Describe DSL technology with its types, advantages and limitations.

### Solution

**DSL (Digital Subscriber Line):**

- **Technology:** High-speed internet over telephone lines
- **Frequency:** Uses higher frequencies than voice

**DSL Types:**

Table 10. DSL Types

Type	Speed	Application
<b>ADSL</b>	Asymmetric (faster download)	Home users
<b>SDSL</b>	Symmetric (equal up/down)	Business
<b>VDSL</b>	Very high speed	Short distances

**Advantages:**

- **Always-on Connection:** No dial-up required
- **Existing Infrastructure:** Uses phone lines
- **Cost-effective:** Affordable high-speed access

**Limitations:**

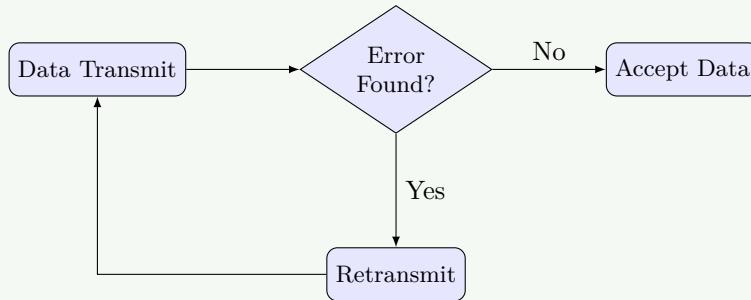
- **Distance Dependent:** Speed decreases with distance
- **Line Quality:** Requires good copper lines
- **Availability:** Not available everywhere

**Mnemonic**

“DSL = Digital Speed Limited by distance”

**Question 3(c OR) [7 marks]**

Explain error control and flow control at data link layer in detail.

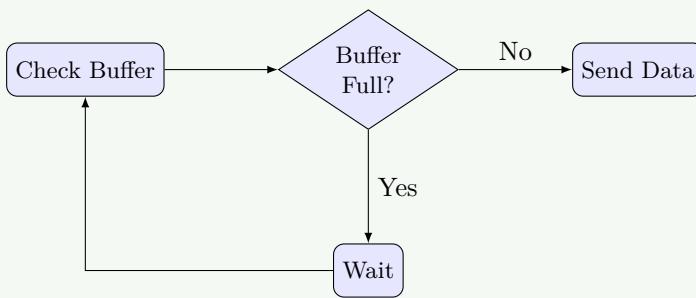
**Solution****Error Control:**

**Figure 6.** Error Control Logic

**Methods:**

**Table 11.** Error Control Methods

Method	Technique	Application
<b>Parity Check</b>	Single bit error detection	Simple systems
<b>Checksum</b>	Mathematical sum verification	TCP/UDP
<b>CRC</b>	Polynomial division	Ethernet, Wi-Fi
<b>ARQ</b>	Automatic Repeat Request	Reliable protocols

**Flow Control:**

**Figure 7.** Flow Control Logic

**Techniques:**

- **Stop-and-Wait:** Send one frame, wait for ACK
- **Sliding Window:** Multiple frames in transit
- **Buffer Management:** Prevents overflow

**Mnemonic**

“EF - Error detection, Flow regulation”

## Question 4(a) [3 marks]

Explain video over IP.

### Solution

#### Video over IP (VoIP):

- **Technology:** Transmits video signals over IP networks
- **Digitization:** Converts analog video to digital packets
- **Real-time:** Requires low latency transmission

#### Components:

- **Encoder:** Compresses video data
- **Network:** IP infrastructure for transport
- **Decoder:** Decompresses at destination

#### Applications:

- **Video Conferencing:** Business communications
- **Streaming:** Entertainment services
- **Surveillance:** Security systems

### Mnemonic

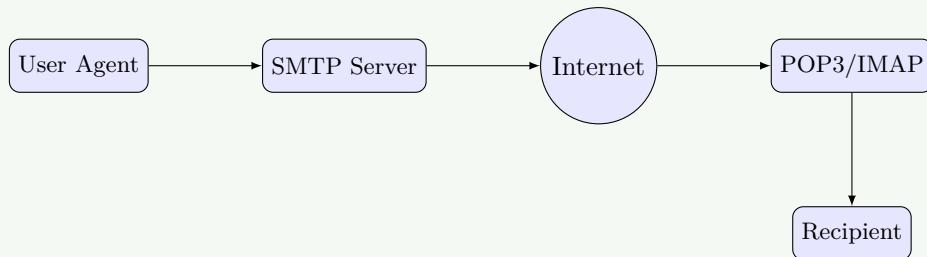
“VIP = Video Internet Protocol”

## Question 4(b) [4 marks]

Explain Electronic-Mail with its protocol.

### Solution

#### Email System Components:



**Figure 8.** Email Architecture

#### Email Protocols:

**Table 12.** Email Protocols

Protocol	Function	Port
<b>SMTP</b>	Send/relay messages	25, 587
<b>POP3</b>	Download messages	110
<b>IMAP</b>	Server-based access	143

#### Message Flow:

- **Composition:** User creates message
- **Submission:** SMTP sends to server
- **Delivery:** Server forwards to recipient
- **Retrieval:** POP3/IMAP downloads message

**Mnemonic**

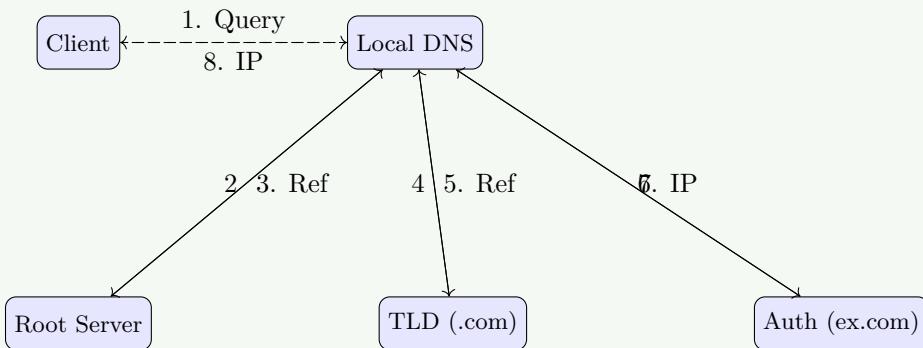
“SPI - SMTP sends, POP3/IMAP receives”

**Question 4(c) [7 marks]**

Explain Role of DNS- Domain Name System Describe the process of DNS resolution.

**Solution****DNS Role:**

- **Name Resolution:** Converts domain names to IP addresses
- **Hierarchical System:** Distributed database structure
- **Internet Navigation:** Makes web browsing user-friendly

**DNS Resolution Process:**

**Figure 9.** Iterative DNS Resolution

**Resolution Steps:**

1. **Local Cache Check:** Check local DNS cache
2. **Recursive Query:** Contact local DNS server
3. **Root Server:** Get TLD server reference
4. **TLD Server:** Get authoritative server reference
5. **Authoritative Server:** Get final IP address
6. **Response Return:** IP address returned to client

**DNS Record Types:**

- **A Record:** Maps name to IPv4 address
- **AAAA Record:** Maps name to IPv6 address
- **CNAME:** Canonical name alias
- **MX:** Mail exchange server

**Mnemonic**

“DNS = Directory Name Service”

**Question 4(a OR) [3 marks]**

Explain WWW, HTML.

**Solution****WWW (World Wide Web):**

- **Definition:** Information system of interlinked documents

- **Access:** Through web browsers using HTTP

- **Components:** Web pages, links, URLs

**HTML (HyperText Markup Language):**

- **Purpose:** Standard markup language for web pages
- **Structure:** Tags define document elements
- **Hyperlinks:** Connect different web resources

**Relationship:**

- **WWW:** The system/platform
- **HTML:** The content format
- **Integration:** HTML creates WWW content

**Mnemonic**

“WWW uses HTML for content”

## Question 4(b OR) [4 marks]

Explain HTTP and FTP.

**Solution**

**Protocol Comparison:**

**Table 13. HTTP vs FTP**

Feature	HTTP	FTP
<b>Purpose</b>	Web page transfer	File transfer
<b>Port</b>	80 (HTTP), 443 (HTTPS)	21 (control), 20 (data)
<b>Connection</b>	Stateless	Stateful
<b>Security</b>	HTTPS for security	FTPS for security

**HTTP (HyperText Transfer Protocol):**

- **Function:** Request-response protocol for web
- **Methods:** GET, POST, PUT, DELETE
- **Stateless:** Each request independent

**FTP (File Transfer Protocol):**

- **Function:** Upload/download files between systems
- **Modes:** Active and Passive
- **Authentication:** Username/password required

**Mnemonic**

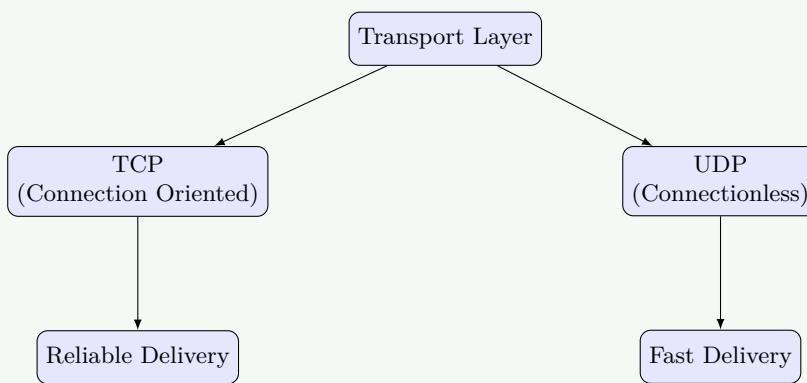
“HF - HTTP for Hypertext, FTP for Files”

## Question 4(c OR) [7 marks]

Explain TCP and UDP protocol in transport layer in relation to connection oriented and connection less network.

**Solution**

**Transport Layer Protocols:**

**Figure 10.** TCP vs UDP Overview**Protocol Comparison:****Table 14.** TCP vs UDP

Feature	TCP	UDP
<b>Connection</b>	Connection-oriented	Connectionless
<b>Reliability</b>	Guaranteed delivery	Best effort
<b>Speed</b>	Slower (overhead)	Faster (minimal overhead)
<b>Header Size</b>	20 bytes	8 bytes
<b>Flow Control</b>	Yes	No
<b>Error Control</b>	Yes	Limited

**Details:**

- **TCP:** Three-way Handshake (SYN, SYN-ACK, ACK), Reliable, Flow Control. Used for Web, Email.
- **UDP:** No Connection Setup, Lightweight, No Guarantees. Used for Video, Gaming, DNS.

**Mnemonic**

“TCP = Thorough, UDP = Ultra-fast”

**Question 2(a OR) [3 marks]**

Explain functions of following network devices: Switch, Router

**Solution****Table 15.** Switch vs Router

Device	Function	Layer
Switch	MAC address learning, Frame forwarding	Data Link (2)
Router	IP routing, Path selection	Network (3)

**Details:**

- **Switch:** Creates separate collision domains per port
- **Router:** Connects different networks, makes routing decisions
- **Intelligence:** Switch learns MAC, Router maintains routing table

**Mnemonic**

“SR - Switch Routes intelligently”

**Question 2(b OR) [4 marks]**

Explain the following term 1) CDDI 2) DHCP and BOOTP

**Solution**

**CDDI (Copper Distributed Data Interface):**

- **Technology:** FDDI over copper cables
- **Speed:** 100 Mbps over twisted pair
- **Cost:** Cheaper alternative to fiber FDDI

**DHCP (Dynamic Host Configuration Protocol):**

- **Function:** Automatic IP address assignment
- **Process:** Discover, Offer, Request, Acknowledge
- **Benefits:** Centralized IP management

**BOOTP (Bootstrap Protocol):**

- **Function:** Network bootstrap for diskless clients
- **Static:** Fixed IP address assignment
- **Predecessor:** Earlier version of DHCP

**Mnemonic**

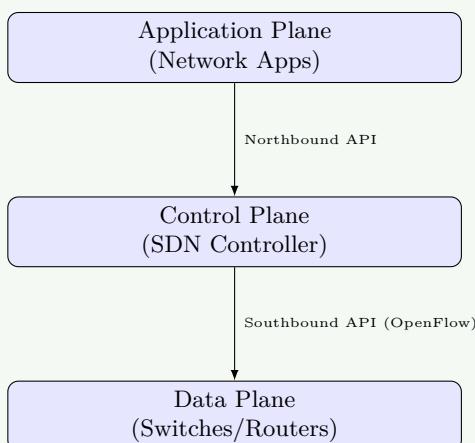
“CDB - CDDI DHCP BOOTP”

**Question 2(c OR) [7 marks]**

Explain Software define network(SDN) with its Architecture, Application, Advantage and limitation.

**Solution**

**SDN Architecture:**



**Figure 11.** SDN Architecture

- **Control Plane:** Centralized network intelligence
- **Data Plane:** Packet forwarding devices
- **Application Plane:** Network applications and services

**Applications:**

- **Cloud Computing:** Dynamic resource allocation
- **Network Virtualization:** Multiple virtual networks
- **Traffic Engineering:** Optimized path selection

**Advantages:**

- **Centralized Control:** Simplified network management
- **Programmability:** Custom network behaviors
- **Flexibility:** Rapid service deployment

**Limitations:**

- **Single Point Failure:** Controller dependency
- **Scalability:** Performance bottlenecks
- **Security:** New attack vectors

**Mnemonic**

“SCAP - Software Control Application Programmable”

**Question 3(a) [3 marks]**

Find the class of following IP address. 1) 01111000 00001111 10101010 11000000 2) 11101000 01010101 11111111 11000011

**Solution**

**Table 16.** IP Address Classification

Binary Address	Decimal	First Octet	Class
01111000...	120.15.170.192	120 (64-127)	Class A
11101000...	232.85.255.195	232 (224-239)	Class D

**Class Ranges:**

- **Class A:** 1-126 (0xxxxxxx)
- **Class B:** 128-191 (10xxxxxx)
- **Class C:** 192-223 (110xxxxx)
- **Class D:** 224-239 (1110xxxx)

**Results:**

- **First IP:** Class A (Unicast)
- **Second IP:** Class D (Multicast)

**Mnemonic**

“ABCD - A(1-126) B(128-191) C(192-223) D(224-239)”

**Question 3(b) [4 marks]**

Differentiate IPv4 and IPv6.

**Solution**

**Table 17.** IPv4 vs IPv6

Feature	IPv4	IPv6
Address Length	32 bits	128 bits
Address Format	Dotted decimal	Hexadecimal
Address Space	4.3 billion	340 undecillion
Header Size	Variable (20-60 bytes)	Fixed (40 bytes)
Security	Optional (IPSec)	Built-in (IPSec)
Configuration	Manual/DHCP	Auto-configuration

**Key Differences:**

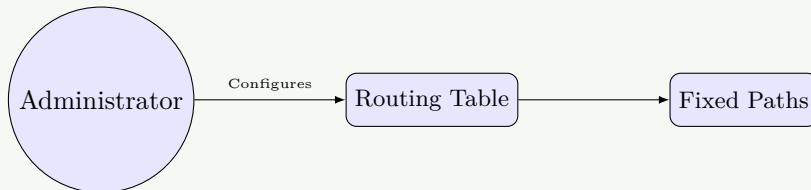
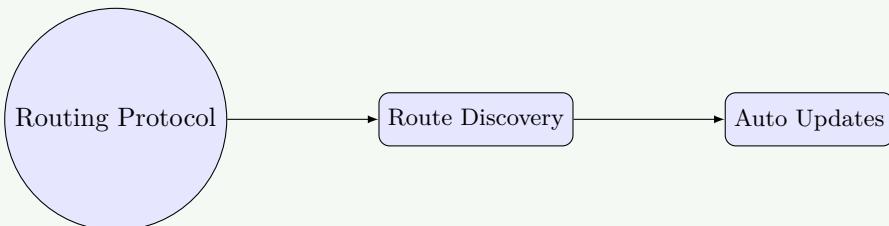
- **Addressing:** IPv6 provides vastly more addresses
- **Security:** IPv6 has mandatory security features
- **Performance:** IPv6 has simplified header structure

**Mnemonic**

“IPv4 to IPv6 = More addresses, Better security”

**Question 3(c) [7 marks]**

Explain Static and Dynamic Routing Algorithms.

**Solution****Static Routing:****Dynamic Routing:**

**Figure 12.** Routing Methods

**Table 18.** Static vs Dynamic Routing

Aspect	Static Routing	Dynamic Routing
Configuration	Manual setup	Automatic discovery
Adaptability	No adaptation	Adapts to changes
Resource Usage	Low CPU/Memory	Higher CPU/Memory
Scalability	Poor for large networks	Good for large networks
Protocols	None required	RIP, OSPF, BGP

**Applications:**

- **Static:** Small networks, specific paths
- **Dynamic:** Large networks, fault tolerance

**Mnemonic**

“SD - Static=Simple, Dynamic=Automatic”

**Question 3(a OR) [3 marks]**

Explain CIDR. How does it differ from traditional IP address allocation methods?

**Solution****CIDR (Classless Inter-Domain Routing):**

- **Concept:** Variable length subnet masking
- **Notation:** IP address/prefix length (e.g., 192.168.1.0/24)
- **Flexibility:** Subnets of any size

**Table 19.** Traditional vs CIDR

Method	Allocation	Efficiency
Traditional	Fixed class boundaries	Wasteful (Class B = 65,536 IPs)
CIDR	Variable subnet sizes	Efficient allocation

**Benefits:**

- **Address Conservation:** Reduces IP address waste
- **Route Aggregation:** Summarizes multiple routes

**Mnemonic**

“CIDR = Classless Intelligent Address Routing”

**Question 3(b OR) [4 marks]**

Describe DSL technology with its types, advantages and limitations.

**Solution****DSL (Digital Subscriber Line):**

**Table 20.** DSL Types

Type	Speed	Application
ADSL	Asymmetric (faster download)	Home users
SDSL	Symmetric (equal up/down)	Business
VDSL	Very high speed	Short distances

**Advantages:**

- **Always-on Connection:** No dial-up required
- **Existing Infrastructure:** Uses phone lines
- **Cost-effective:** Affordable high-speed access

**Limitations:**

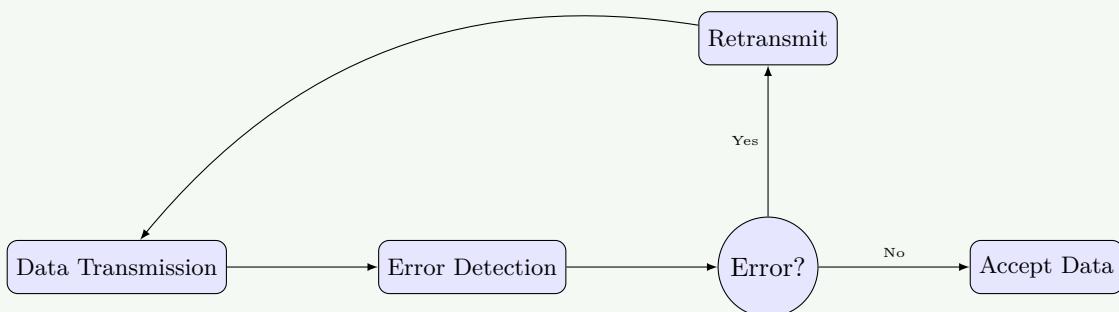
- **Distance Dependent:** Speed decreases with distance
- **Line Quality:** Requires good copper lines
- **Availability:** Not available everywhere

**Mnemonic**

“DSL = Digital Speed Limited by distance”

**Question 3(c OR) [7 marks]**

Explain error control and flow control at data link layer in detail.

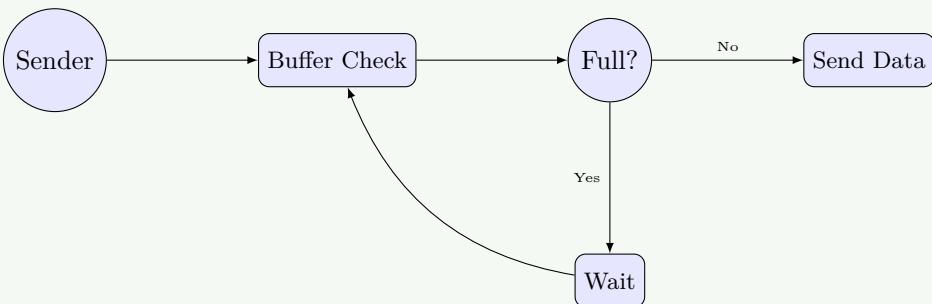
**Solution****Error Control:**

**Figure 13.** Error Control Logic

**Error Control Methods:**

**Table 21.** Error Control Methods

Method	Technique	Application
Parity Check	Single bit error detection	Simple systems
Checksum	Mathematical sum verification	TCP/UDP
CRC	Polynomial division	Ethernet, Wi-Fi
ARQ	Automatic Repeat Request	Reliable protocols

**Flow Control:**

**Figure 14.** Flow Control Logic

**Techniques:**

- **Stop-and-Wait:** Send one frame, wait for ACK
- **Sliding Window:** Multiple frames in transit
- **Buffer Management:** Prevents overflow

**Mnemonic**

“EF - Error detection, Flow regulation”

## Question 4(a) [3 marks]

Explain video over IP.

### Solution

#### Video over IP (VoIP):

- **Technology:** Transmits video signals over IP networks
- **Digitization:** Converts analog video to digital packets
- **Real-time:** Requires low latency transmission

#### Components:

- **Encoder:** Compresses video data
- **Network:** IP infrastructure for transport
- **Decoder:** Decompresses at destination

#### Applications:

- Video Conferencing, Streaming, Surveillance

### Mnemonic

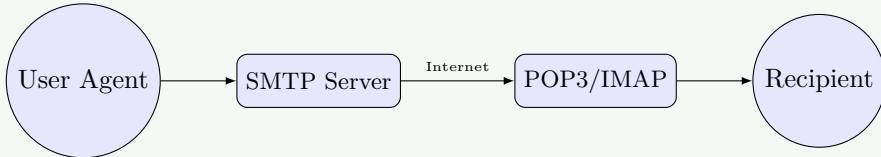
“VIP = Video Internet Protocol”

## Question 4(b) [4 marks]

Explain Electronic-Mail with its protocol.

### Solution

#### Email System:



**Figure 15.** Email Architecture

**Table 22.** Email Protocols

Protocol	Function	Port	Direction
SMTP	Send/relay messages	25, 587	Sending
POP3	Download messages	110	Receiving
IMAP	Server-based access	143	Advanced Ret.

#### Message Flow:

- Composition → Submission → Delivery → Retrieval

### Mnemonic

“SPI - SMTP sends, POP3/IMAP receives”

## Question 4(c) [7 marks]

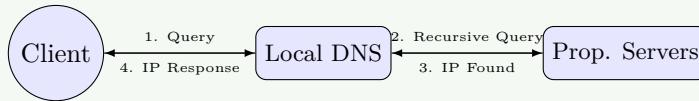
Explain Role of DNS- Domain Name System Describe the process of DNS resolution.

### Solution

#### DNS Role:

- **Name Resolution:** Converts domain names to IP addresses
- **Hierarchical System:** Distributed database structure
- **Internet Navigation:** Makes web browsing user-friendly

#### DNS Resolution Process:



**Figure 16.** Simplified DNS Resolution

#### Resolution Steps:

1. **Local Cache Check:** Check local DNS cache
2. **Recursive Query:** Contact local DNS server
3. **Root Server:** Get TLD server reference
4. **TLD/Auth Server:** Get final IP address
5. **Response Return:** IP address returned to client

#### DNS Record Types:

- **A Record:** IPv4 address
- **AAAA Record:** IPv6 address
- **CNAME:** Alias
- **MX:** Mail Exchange

### Mnemonic

“DNS = Directory Name Service”

## Question 4(a OR) [3 marks]

Explain WWW, HTML.

### Solution

#### WWW (World Wide Web):

- **Definition:** Information system of interlinked documents
- **Access:** Through web browsers using HTTP
- **Components:** Web pages, links, URLs

#### HTML (HyperText Markup Language):

- **Purpose:** Standard markup language for web pages
- **Structure:** Tags define document elements
- **Hyperlinks:** Connect different web resources

#### Relationship:

- WWW: System/Platform
- HTML: Content Format

### Mnemonic

“WWW uses HTML for content”

## Question 4(b OR) [4 marks]

Explain HTTP and FTP.

**Solution****Table 23.** HTTP vs FTP

Feature	HTTP	FTP
Purpose	Web page transfer	File transfer
Port	80 (HTTP), 443 (HTTPS)	21 (control), 20 (data)
Connection	Stateless	Stateful
Security	HTTPS for security	FTPS for security

**HTTP (HyperText Transfer Protocol):**

- **Function:** Request-response protocol for web
- **Methods:** GET, POST, PUT, DELETE
- **Stateless:** Each request independent

**FTP (File Transfer Protocol):**

- **Function:** Upload/download files between systems
- **Modes:** Active and Passive
- **Authentication:** Username/password required

**Mnemonic**

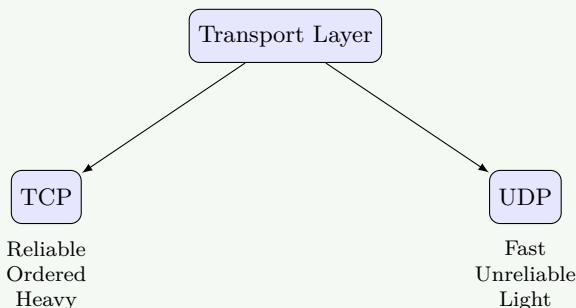
“HF - HTTP for Hypertext, FTP for Files”

**Question 4(c OR) [7 marks]**

Explain TCP and UDP protocol in transport layer in relation to connection oriented and connection less network.

**Solution****Table 24.** TCP vs UDP

Feature	TCP	UDP
Connection	Connection-oriented	Connectionless
Reliability	Guaranteed delivery	Best effort
Speed	Slower (overhead)	Faster (minimal overhead)
Header	20 bytes	8 bytes
Flow Control	Yes	No
Error Control	Yes	Limited

**Protocol Diagram:****Figure 17.** Transport Protocols**Description:**

- **TCP:** Three-way handshake (SYN, SYN-ACK, ACK), reliable delivery, flow control used for web/email.
- **UDP:** Fire-and-forget, no connection setup, used for streaming/gaming where speed matters.

### Mnemonic

“TCP = Thorough, UDP = Ultra-fast”

## Question 5(a) [3 marks]

Describe Hacking and its related precautions.

### Solution

#### Hacking Definition:

- **Unauthorized Access:** Breaking into computer systems
- **Malicious Intent:** Steal, modify, or destroy data
- **Security Breach:** Exploit system vulnerabilities

**Table 25.** Security Precautions

Measure	Implementation
Strong Passwords	Complex, unique passwords
Software Updates	Regular patches and updates
Firewalls	Network access control
Antivirus	Malware detection and removal
Backup	Regular data backups
User Training	Security awareness programs

### Mnemonic

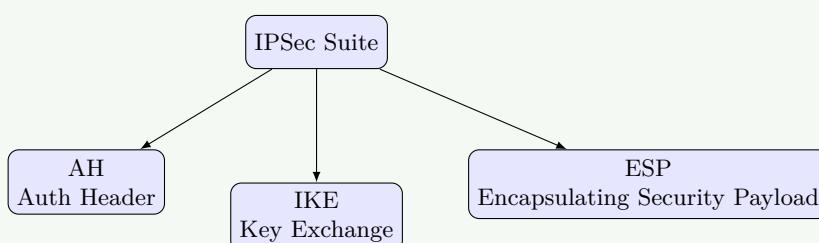
“HSPFAB - Hacking Stopped by Passwords, Firewalls, Antivirus, Backups”

## Question 5(b) [4 marks]

Explain IPSec architecture.

### Solution

#### IPSec Architecture:



**Figure 18.** IPSec Components

**Table 26.** IPSec Components

Component	Function
AH	Authentication and integrity (No encryption)
ESP	Confidentiality and authentication (Encryption)
SA	Security parameter agreement
IKE	Key management protocol

**Modes:**

- **Transport Mode:** Protects payload only
- **Tunnel Mode:** Protects transmission (entire packet)

**Mnemonic**

“AISE - AH, IPSec, SA, ESP”

**Question 5(c) [7 marks]**

Explain network Security topologies.

**Solution****Security Topology:**

**Figure 19.** Network Security Zones

**Table 27.** Security Zones

Zone	Purpose	Level
Internet	External untrusted network	Lowest
DMZ	Semi-trusted public services	Medium
Internal	Private trusted network	Highest

**Principles:**

- **Defense in Depth:** Multiple layers
- **Least Privilege:** Minimum access
- **Segmentation:** Isolate critical systems

**Mnemonic**

“NST = Network Security Through topology design”

**Question 5(a OR) [3 marks]**

Explain ISO and how it contributes to information security?

**Solution****ISO (International Organization for Standardization):**

- **Global Standards:** Develops international standards
- **ISO 27001:** Standard for Information Security

- **ISMS:** Information Security Management System framework

**Contribution:**

- Provides risk management framework, ensures compliance, and establishes best practices for data protection.

**Mnemonic**

“ISO = International Security Organization”

## Question 5(b OR) [4 marks]

Give Difference between symmetric and asymmetric encryption algorithms.

**Solution**

**Table 28.** Symmetric vs Asymmetric Encryption

Feature	Symmetric	Asymmetric
Keys	Single shared key	Key pair (Public/Private)
Speed	Fast	Slower
Key Dist.	Difficult	Easier
Scalability	Poor ( $n^2$ keys)	Better
Examples	AES, DES	RSA, ECC

**Hybrid Approach:**

- Use Asymmetric for secure key exchange, then Symmetric for data transfer (Best of both).

**Mnemonic**

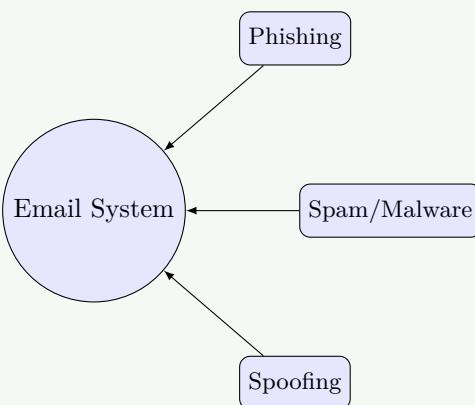
“SA = Symmetric Shared, Asymmetric Apart”

## Question 5(c OR) [7 marks]

Explain Email security with its standards.

**Solution**

**Email Threats:**



**Figure 20.** Email Threats

**Table 29.** Email Security Standards

Standard	Purpose	Function
S/MIME	Content Security	Encryption/Signatures
PGP	Privacy	End-to-end encryption
TLS	Transport Security	Secure transmission
SPF	Sender Auth	Prevent spoofing
DKIM	Integrity	Signature verification
DMARC	Policy	Auth policy enforcement

**Mechanisms:**

- **Encryption:** Confidentiality
- **Digital Signatures:** Integrity & Non-repudiation

**Mnemonic**

“SPTSD = S/MIME, PGP, TLS, SPF, DKIM protect email”

**Question 5(a) [3 marks]**

Describe Hacking and its related precautions.

**Solution****Hacking Definition:**

- **Unauthorized Access:** Breaking into computer systems
- **Malicious Intent:** Steal, modify, or destroy data
- **Security Breach:** Exploit system vulnerabilities

**Types of Hacking:**

- **Ethical Hacking:** Authorized security testing
- **Malicious Hacking:** Criminal activities
- **Social Engineering:** Manipulate human behavior

**Precautions:****Table 30.** Security Measures

Security Measure	Implementation
<b>Strong Passwords</b>	Complex, unique passwords
<b>Software Updates</b>	Regular patches and updates
<b>Firewalls</b>	Network access control
<b>Antivirus</b>	Malware detection and removal
<b>Backup</b>	Regular data backups
<b>User Training</b>	Security awareness programs

**Mnemonic**

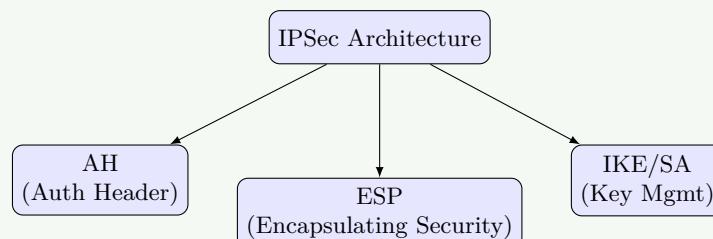
“HSPFAB - Hacking Stopped by Passwords, Firewalls, Antivirus, Backups”

**Question 5(b) [4 marks]**

Explain IPSec architecture.

### Solution

**IPSec (Internet Protocol Security):**



**Figure 21.** IPSec Architecture Components

**IPSec Components:**

- **AH:** Authentication and integrity
- **ESP:** Confidentiality and authentication
- **SA:** Security parameter agreement
- **IKE:** Key management protocol

**Operating Modes:**

- **Transport Mode:** Protects payload only
- **Tunnel Mode:** Protects entire IP packet

**Security Services:**

- **Authentication:** Verify sender identity
- **Integrity:** Ensure data unchanged
- **Confidentiality:** Encrypt data content
- **Anti-replay:** Prevent packet replay attacks

### Mnemonic

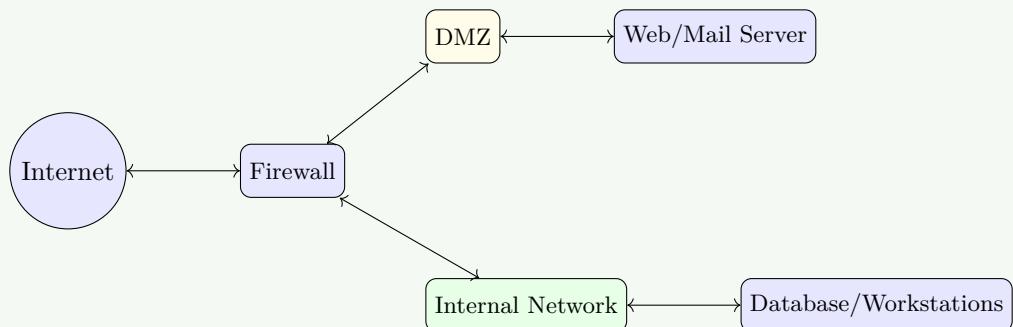
“AISE - AH, IPSec, SA, ESP”

## Question 5(c) [7 marks]

Explain network Security topologies.

### Solution

**Network Security Topologies:**



**Figure 22.** DMZ Network Topology

**Security Zones:**

**Table 31.** Security Zones

Zone	Purpose	Security Level
Internet	External untrusted network	Lowest
DMZ	Semi-trusted public services	Medium
Internal	Private trusted network	Highest

**Topology Components:**

- **Perimeter Security:** Firewalls, IDS/IPS
- **Network Segmentation:** VLANs, subnets
- **Access Control:** Authentication, authorization

**Security Principles:**

- **Defense in Depth:** Multiple security layers
- **Least Privilege:** Minimum required access
- **Network Isolation:** Separate critical systems

**Mnemonic**

“NST = Network Security Through topology design”

**Question 5(a OR) [3 marks]**

Explain ISO and how it contributes to information security?

**Solution****ISO (International Organization for Standardization):**

- **Global Standards:** Develops international standards
- **Quality Assurance:** Ensures consistent practices
- **Best Practices:** Provides framework for implementation

**ISO 27001 - Information Security:**

- **ISMS:** Information Security Management System
- **Risk Management:** Systematic approach to security
- **Continuous Improvement:** Regular review and updates

**Benefits:**

- **Standardization:** Common security language
- **Credibility:** International recognition
- **Improvement:** Ongoing security enhancement

**Mnemonic**

“ISO = International Security Organization”

**Question 5(b OR) [4 marks]**

Give Difference between symmetric and asymmetric encryption algorithms.

**Solution****Encryption Algorithm Comparison:**

**Table 32.** Symmetric vs Asymmetric Encryption

Feature	Symmetric	Asymmetric
<b>Keys</b>	Single shared key	Key pair (public/private)
<b>Speed</b>	Fast	Slower
<b>Key Distribution</b>	Difficult	Easier
<b>Scalability</b>	Poor ( $n^2 - 1$ keys)	Better
<b>Security</b>	Depends on key secrecy	Mathematical complexity

**Symmetric Encryption:**

- **Process:** Same key encrypts and decrypts
- **Challenge:** Secure key distribution
- **Examples:** AES, DES, 3DES

**Asymmetric Encryption:**

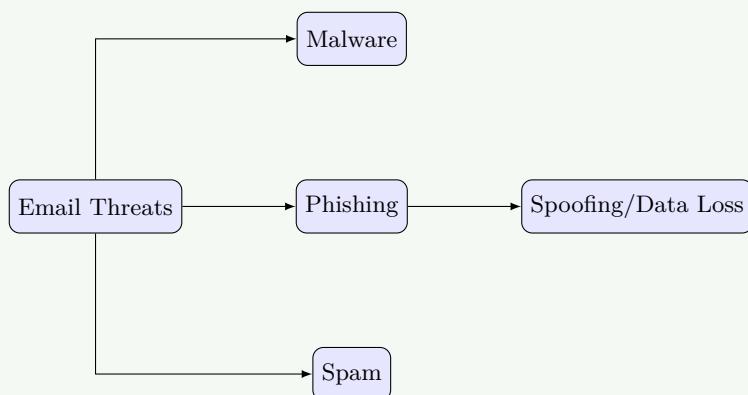
- **Process:** Public key encrypts, private key decrypts
- **Advantage:** No key distribution problem
- **Examples:** RSA, ECC, Diffie-Hellman

**Mnemonic**

“SA = Symmetric Shared, Asymmetric Apart”

**Question 5(c OR) [7 marks]**

Explain Email security with its standards.

**Solution****Email Security Challenges:**

**Figure 23.** Email Security Threats

**Email Security Standards:**

**Table 33.** Security Standards

Standard	Purpose	Function
<b>S/MIME</b>	Secure email content	Encryption and digital signatures
<b>PGP</b>	Pretty Good Privacy	End-to-end encryption
<b>TLS</b>	Transport security	Secure email transmission
<b>SPF</b>	Sender authentication	Prevent email spoofing
<b>DKIM</b>	Message integrity	Digital signature verification
<b>DMARC</b>	Policy enforcement	Email authentication policy

**Security Mechanisms:**

- **Encryption:** Protect message content
- **Digital Signatures:** Verify sender identity (Authentication)
- **Integrity:** Ensure message unchanged

**Best Practices:**

- **User Education:** Recognize phishing attempts
- **Gateway Filtering:** Block malicious emails
- **Regular Updates:** Keep security software current

**Mnemonic**

“SPTSD - S/MIME, PGP, TLS, SPF, DKIM protect email”