

Subject Name Solutions

4343202 – Winter 2024

Semester 1 Study Material

Detailed Solutions and Explanations

Question 1(a) [3 marks]

What is the Computer Network? Why it is important?

Solution

A computer network is a collection of interconnected computing devices that can exchange data and share resources.

Diagram:

[illegible]

- **Resource sharing:** Enables sharing of printers, files, applications
- **Communication:** Facilitates information exchange between users
- **Scalability:** Allows networks to grow as needs increase

Mnemonic

“CSI” - “Connect, Share, Interact”

Question 1(b) [4 marks]

Define terms: 1) Web Server, 2) Encrypted data, 3) Hacking, 4) Client-server

Solution

Term	Definition
Web Server	Software/hardware that serves web content to clients using HTTP/HTTPS
Encrypted Data	Information converted to code to prevent unauthorized access
Hacking	Unauthorized access to computer systems through security vulnerabilities
Client-Server	Network model where centralized servers provide services to client computers

Diagram:

CLIENT{-SERVER MODEL:}

[illegible]

Mnemonic

“WECHS” - “Web servers Encrypt data, Clients and Hackers use Servers”

Mnemonic

“WECHS” - “Web servers Encrypt data, Clients and Hackers use Servers”

Question 1(c) [7 marks]

Classify and explain the transmission media in detail.

Solution

Transmission media are physical pathways that carry data in a network.

Category	Types	Characteristics	Applications
Guided Media			
Twisted Pair	UTP, STP	100m range, 10Mbps-10Gbps	Office LANs
Coaxial Cable	Baseband, Broadband	500m range, 10-100Mbps	Cable TV, Internet
Fiber Optic	Single-mode, Multi-mode	Long distance, 100Mbps-100Gbps	Backbone, WAN
Unguided Media			
Radio Waves	WiFi, Cellular	Omnidirectional, 1-100Mbps	Wireless networks
Microwaves	Terrestrial, Satellite	Line-of-sight, 1-10Gbps	Point-to-point links
Infrared	IrDA	Short-range, 4-16Mbps	Remote controls

Diagram:

GUIDED MEDIA:

GUIDED MEDIA:
Twisted Pair: ={{=====}}

GUIDED MEDIA:
Twisted Pair: = {=====}
Coaxial: ===== | ===== | =====

```
GUIDED MEDIA:
  Twisted Pair:  ={{=====}}
  Coaxial:       =====|=====|=====
  Fiber Optic:   ====={{}}
```

UNGUIDED MEDIA:

```

UNGUIDED MEDIA:
Radio:      ((( o )))
Mi         [[ 26 26 2 6 26 26 26 26 ]]
```

```

UNGUIDED MEDIA:
  Radio:      ((( o )))
  Microwave:  {-}{-}{-} {-}{-}{-}
  Infrared:   [ ]

```

```

UNGUIDED MEDIA:
  Radio:      ((( o )))
  Microwave:  {-}{-}{-} {-}{-}{-}
  Infrared:   * * * {}

```

- **Guided media:** Physical paths for signal confinement
- **Unguided media:** Wireless transmission through air/space
- **Selection factors:** Cost, bandwidth, distance, environment

Mnemonic

“TCFRIM” - “Twisted pair, Coaxial, Fiber, Radio, Infrared, Microwave”

Question 1(c) OR [7 marks]

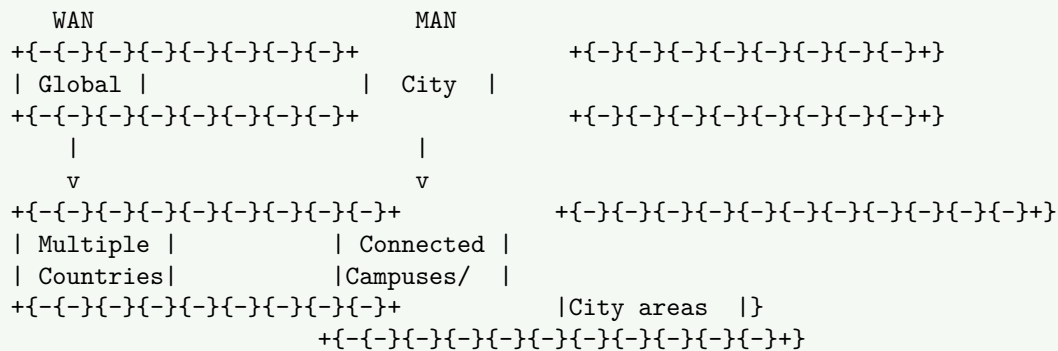
Explain WAN and MAN type of network.

Solution

Wide Area Networks (WAN) and Metropolitan Area Networks (MAN) are network types classified by geographic scope.

Feature	MAN (Metropolitan Area Network)	WAN (Wide Area Network)
Coverage	City-wide (5-50 km)	Country/Global (>50 km)
Speed	10 Mbps - 10 Gbps	1.5 Mbps - 1 Gbps
Ownership	Municipal/Telecom	Multiple organizations
Technologies	Ethernet, SONET, WiMAX	Frame Relay, ATM, MPLS
Examples	City networks, Campus networks	Internet, Corporate networks

Diagram:



- **MAN:** Connects LANs within a city/metropolitan area
- **WAN:** Spans large geographical areas across cities/countries
- **Management:** WAN typically requires service providers
- **Infrastructure:** Different transmission media and technologies

Mnemonic

“SWIM” - “Size: WAN Is Massive compared to MAN”

Question 2(a) [3 marks]

Explain in detail: Transmission technology.

Solution

Transmission technology refers to methods used to transfer data between network devices.

Technology Type	Description	Example
Point-to-Point	Direct connection between two nodes	Leased line
Broadcast	Single communication channel shared by all nodes	Wireless LAN
Multipoint	Multiple devices share single link	Cable networks

- **Analog transmission:** Continuous signal, susceptible to noise
- **Digital transmission:** Discrete signal, more reliable
- **Baseband:** Single signal uses entire bandwidth (Ethernet)
- **Broadband:** Multiple signals share bandwidth (Cable TV)

Mnemonic

“ABP-DMB” - “Analog or Baseband, Point-to-point; Digital or Multipoint, Broadcast”

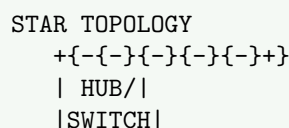
Question 2(b) [4 marks]

Draw and explain Star topology in detail.

Solution

Star topology is a network configuration where all devices connect to a central hub/switch.

Diagram:



- **Application Layer:** Interface between applications and network
- **Transport Layer:** Reliable data transfer between end systems
- **Internet Layer:** Routing packets across networks
- **Network Access Layer:** Physical connection to network media

Mnemonic

“ATNI” - “Application Talks, Network Internet Interfaces”

Question 2(a) OR [3 marks]

Draw and explain Bus topology in detail

Solution

Bus topology is a network configuration where all devices connect to a single communication line.
Diagram:

BUS TOPOLOGY

```
BUS TOPOLOGY
+{-}{-}{-}{-}{-}+      +{-}{-}{-}{-}{-}{-}+      +{-}{-}{-}{-}{-}{-}+      +{-}{-}{-}{-}{-}{-}+
|Node1|====|Node2|====|Node3|====|Node4|
+{-}{-}{-}{-}{-}{-}+      +{-}{-}{-}{-}{-}{-}{-}+      +{-}{-}{-}{-}{-}{-}{-}+      +{-}{-}{-}{-}{-}{-}{-}+
|
+{-}{-}{-}{-}{-}{-}{-}+
|Node5|
+{-}{-}{-}{-}{-}{-}{-}+
```

Advantages	Disadvantages
Simple layout	Single point of failure (main cable)
Less cabling	Limited cable length
Low cost	Performance degrades with more nodes
Easy to extend	Difficult to troubleshoot

- **Operation:** Data travels along the bus in both directions
- **Terminator:** Required at both ends to prevent signal reflection
- **Usage:** Primarily in older networks, small setups

Mnemonic

“SLUE” - “Simple Layout, Uses less cable, Easy installation”

Question 2(b) OR [4 marks]

Explain Network Classification based on its architecture.

Solution

Networks can be classified based on their architectural models that define how devices interact.

Architecture	Characteristics	Example
Peer-to-Peer	Equal privileges, no dedicated servers	Home networks, small workgroups
Client-Server	Centralized services, dedicated servers	Enterprise networks, web services
Three-Tier	Presentation, application, and data tiers	Modern web applications
N-Tier	Multiple specialized tiers	Large distributed systems

Diagram:

```

PEER{-TO{-}PEER:                                CLIENT{-}SERVER:}
+{-{-}{-}{-}+      +{-}{-}{-}{-}+      +{-}{-}{-}{-}{-}{-}+}
|Node|{-{-}{-}{-}|-}Node|      |Client|}
+{-{-}{-}{-}+      /+{-}{-}{-}{-}+      +{-}{-}{-}{-}{-}{-}+}
      { /      |}
      X      +{-{-}{-}{-}{-}+}
      / {      |Server|}
+{-{-}{-}{-}+ /      +{-}{-}{-}{-}+      +{-}{-}{-}{-}{-}{-}+}
|Node|{-{-}{-}{-}|-}Node|}
+{-{-}{-}{-}+      +{-}{-}{-}{-}+}

```

- **Peer-to-Peer:** Direct device communication, distributed resources
- **Client-Server:** Centralized resource management, better security
- **Hybrid:** Combines elements of both architectures

Mnemonic

“PCAN” - “Peer-to-peer, Client-server, Architecture Networks”

Mnemonic

“PCAN” - “Peer-to-peer, Client-server, Architecture Networks”

Question 2(c) OR [7 marks]

Explain classification of IP address.

Solution

IP addresses are classified into different categories based on their structure and purpose.

IP Classification	Range	Default Mask	Available Networks	Hosts/Network
Class A	1.0.0.0 - 127.255.255.255	255.0.0.0 (/8)	126	16,777,214
Class B	128.0.0.0 - 191.255.255.255	255.255.0.0 (/16)	16,384	65,534
Class C	192.0.0.0 - 223.255.255.255	255.255.255.0 (/24)	2,097,152	254
Class D (Multicast)	224.0.0.0 - 239.255.255.255	N/A	N/A	N/A
Class E (Reserved)	240.0.0.0 - 255.255.255.255	N/A	N/A	N/A

Special IP Ranges:

- **Private IPs:** 10.0.0.0/8, 172.16.0.0/12, 192.168.0.0/16
- **Loopback:** 127.0.0.0/8 (typically 127.0.0.1)
- **Link-local:** 169.254.0.0/16

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 - **Loopback:** 127.0.0.0/8 (typically 127.0.0.1)
 - **Link-local:** 169.254.0.0/16

Diagram:

CLASS A:	0	NETWORK(7 bits)		HOST(24 bits)	
CLASS B:	10	NETWORK(14 bits)		HOST(16 bits)	
CLASS C:	110	NETWORK(21 bits)		HOST(8 bits)	
CLASS D:	1110	MULTICAST ADDRESS(28 bits)			
CLASS E:	1111	RESERVED ADDRESS(28 bits)			

- **Classful addressing:** Original IP address classification scheme
- **CIDR (Classless):** Modern approach that allows flexible subnet masks
- **IPv4 vs IPv6:** IPv4 uses 32-bit addresses, IPv6 uses 128-bit addresses

Mnemonic

“ABCDE” - “Address Blocks Categorized by Decreasing End-host counts”

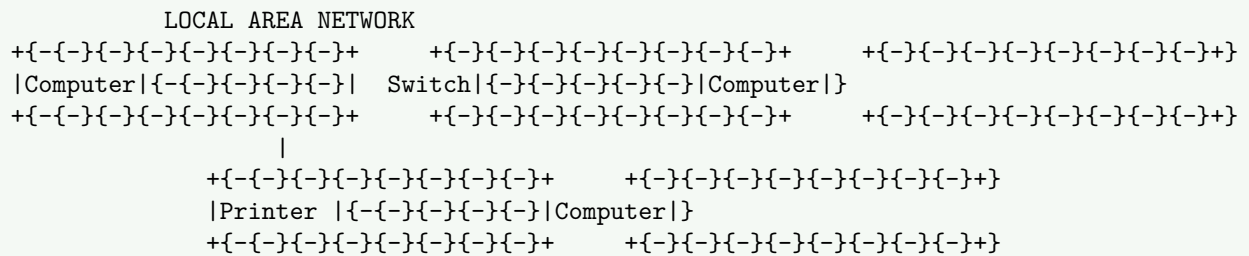
Question 3(a) [3 marks]

What is full name of LAN? Explain it in detail.

Solution

LAN stands for Local Area Network, a network confined to a limited geographic area.

Diagram:



LAN Characteristics	Description
Geographic Scope	Building, campus, or small area (1-2 km)
Data Rate	High (10 Mbps to 10 Gbps)
Ownership	Single organization or individual
Technology	Ethernet, WiFi, Token Ring
Media	Twisted pair, fiber optic, wireless

- **Purpose:** Connect nearby devices for resource sharing
- **Administration:** Easier management than larger networks
- **Applications:** Office networking, home networking

Mnemonic

“LOCAL” - “Limited in range, Owned by one entity, Connected devices, Access control, Low latency”

Question 3(b) [4 marks]

Write a short-note of Repeater.

Solution

A repeater is a network device that amplifies and regenerates signals to extend network range.

Diagram:



Feature	Description
OSI Layer	Physical Layer (Layer 1)
Function	Signal regeneration and amplification
Purpose	Extend network transmission distance

Limitation Cannot filter traffic or connect different networks

- **Operation:** Receives, regenerates, and retransmits signals
- **Usage:** Extending cable length beyond normal limits
- **Types:** Traditional repeaters, hubs (multiport repeaters)

Mnemonic

“RARE” - “Repeaters Amplify and Regenerate Electrical signals”

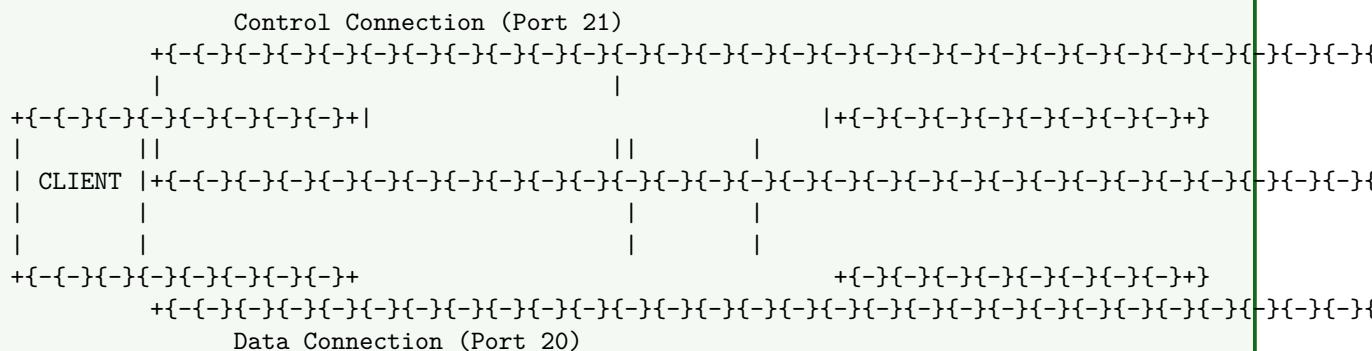
Question 3(c) [7 marks]

Write short note on FTP.

Solution

File Transfer Protocol (FTP) is a standard network protocol for transferring files between clients and servers.

Diagram:



Feature	Description
Port	Control: 21, Data: 20
Mode	Active or Passive
Authentication	Username/password (or anonymous)
Transfer Types	ASCII (text) or Binary (raw data)
Security	Basic FTP (unsecured), FTPS, SFTP (secure variants)

- **Dual Channel:** Separate control and data connections
- **Commands:** GET, PUT, LIST, DELETE, RENAME, etc.
- **User Authentication:** Requires login credentials

Mnemonic

“CDATA” - “Control channel, Data channel, Active/passive modes, Transfer types, Authentication”

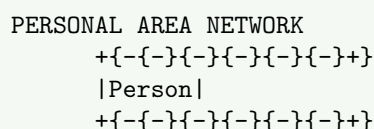
Question 3(a) OR [3 marks]

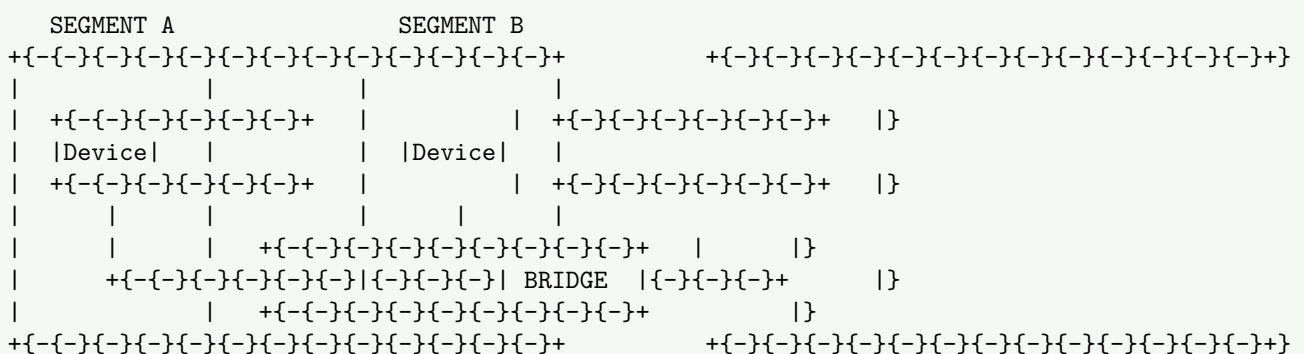
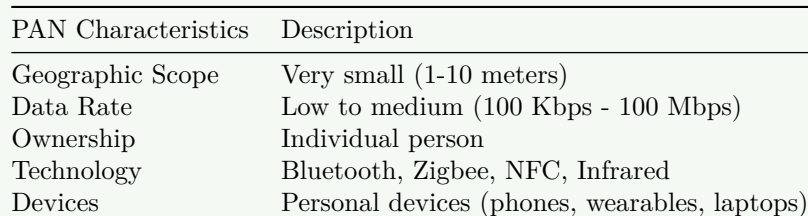
What is full name of PAN? Explain in detail.

Solution

PAN stands for Personal Area Network, a network for connecting devices centered around an individual.

Diagram:





Mnemonic

“SELF” - “Segmentation, Extension, Learning addresses, Filtering traffic”

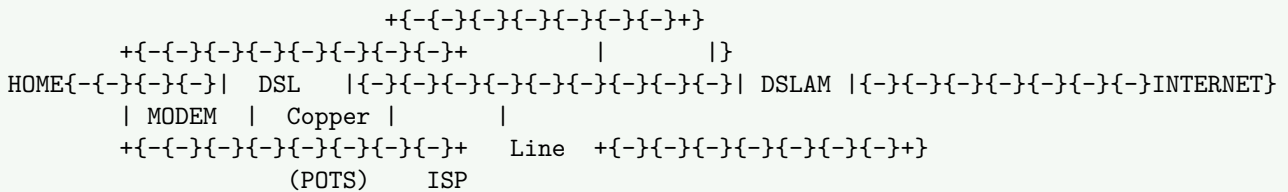
Question 3(c) OR [7 marks]

What is DSL? Explain its different types.

Solution

Digital Subscriber Line (DSL) is a family of technologies that provides digital data transmission over telephone lines.

Diagram:



DSL Type	Full Name	Speed (Down/Up)	Distance	Application
ADSL	Asymmetric DSL	8 Mbps/1 Mbps	Up to 5.5 km	Residential internet
SDSL	Symmetric DSL	2 Mbps/2 Mbps	Up to 3 km	Small business
VDSL	Very high-bit-rate DSL	52-85 Mbps/16-85 Mbps	Up to 1.2 km	Video streaming, businesses
HDSL	High-bit-rate DSL	2 Mbps/2 Mbps	Up to 3.6 km	T1/E1 replacement
IDSL	ISDN DSL	144 Kbps/144 Kbps	Up to 5.5 km	ISDN alternative

- **Working Principle:** Uses unused frequency spectrum on phone lines
- **Advantage:** Uses existing telephone infrastructure
- **Always-on:** Continuous connection without dial-up

Mnemonic

“SAVHI” - “Symmetric, Asymmetric, Very high-bit-rate, High-bit-rate, ISDN DSL”

Question 4(a) [3 marks]

Explain an error control and flow control at data link layer.

Solution

Error and flow control are essential data link layer functions that ensure reliable data transmission.

Mechanism	Purpose	Techniques
Error Control	Detect/correct transmission errors	CRC, Checksums, Parity bits
Flow Control	Prevent sender overwhelming receiver	Stop-and-wait, Sliding window

Diagram:

ERROR CONTROL:

+{-}{-}{-}{-}{-}{-}{-}+ DATA	+{-}{-}{-}{-}{-}{-}{-}{-}+ ACK/NAK	+{-}{-}{-}{-}{-}{-}{-}{-}{-}
Sender {-}{-}{-}{-}{-}{-}{-} Channel {-}{-}{-}{-}{-}{-}{-}{-} Receiver }		
+{-}{-}{-}{-}{-}{-}{-}+	+{-}{-}{-}{-}{-}{-}{-}+	+{-}{-}{-}{-}{-}{-}{-}{-}{-}

FLOW CONTROL:

+{-}{-}{-}{-}{-}{-}{-}+ DATA	+{-}{-}{-}{-}{-}{-}{-}{-}{-}
Sender {-}{-}{-}{-}{-}{-}{-} Receiver }	
+{-}{-}{-}{-}{-}{-}{-}+ STOP	+{-}{-}{-}{-}{-}{-}{-}{-}{-}
{ {- } { - } { - } { - } { - } { - } { - } }	

- **Error Detection:** CRC, checksum identify corrupted frames
- **Error Correction:** Forward Error Correction (FEC), retransmission
- **Flow Control:** Prevents buffer overflow at receiver

Mnemonic

“SAFE” - “Stop-and-wait, Acknowledgment, Flow control, Error detection”

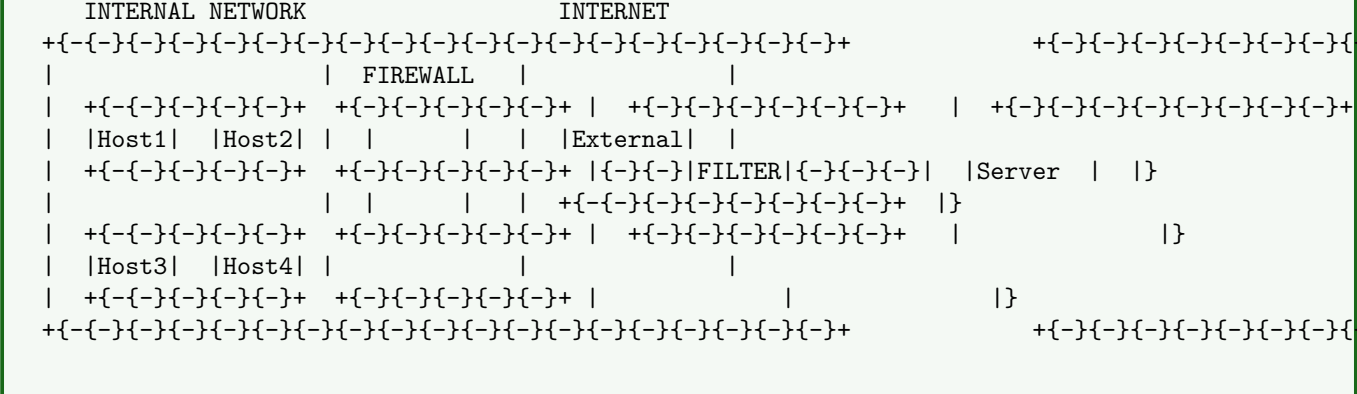
Question 4(b) [4 marks]

What is Firewall? Explain it in detail.

Solution

A firewall is a network security device that monitors and filters incoming and outgoing network traffic.

Diagram:



Firewall Type	Functionality	Example
Packet Filtering	Examines packet headers	Router ACLs
Stateful Inspection	Tracks connection state	Most hardware firewalls
Application Layer	Inspects content	Web application firewalls
Next-Generation	Combines multiple technologies	Palo Alto, Fortinet

- **Purpose:** Protects networks from unauthorized access
- **Implementation:** Hardware, software, or cloud-based
- **Security Policy:** Rules defining allowed/blocked traffic

Mnemonic

“PAPSI” - “Packet filtering, Application layer, Policies, Stateful inspection”

Question 4(c) [7 marks]

Compare IPV4 and IPV6.

Solution

IPv4 and IPv6 are Internet Protocol versions with significant differences in addressing and capabilities.

Feature	IPv4	IPv6
Address Size	32-bit (4 bytes)	128-bit (16 bytes)
Format	Dotted decimal (192.168.1.1)	Hexadecimal with colons (2001:0db8:85a3::8a2e:0370:7334)
Address Space	~4.3 billion addresses	340 undecillion addresses
Header	Variable length (20-60 bytes)	Fixed length (40 bytes)
Fragmentation	Routers and sending hosts	Only sending hosts
Checksum	Included in header	Removed from header
Security	Not built-in (IPsec optional)	Built-in IPsec support

Diagram:

```

IPv4: |VER|IHL|DSCP|ECN|  TOTAL LENGTH  |
      |  IDENTIFICATION  |FLAGS|FRAGMENT|
      |TTL |PROTOCOL|  HEADER CHECKSUM  |
      |      SOURCE ADDRESS      |
      |      DESTINATION ADDRESS  |
      |      OPTIONS...          |

IPv6: |VER|TRAFFIC CLASS|      FLOW LABEL      |
      |  PAYLOAD LENGTH  |NEXT HDR|HOP LIMIT|
      |
      |      SOURCE ADDRESS      |
      |
      |
      |
      |      DESTINATION ADDRESS  |
      |

```

- **Auto-configuration:** IPv6 has stateless address auto-configuration
- **NAT:** Not required in IPv6 due to larger address space
- **Transition:** Dual-stack, tunneling, translation mechanisms
- **Header efficiency:** IPv6 has streamlined header for better performance

Mnemonic

“SHAPE” - “Size, Header, Addressing, Performance, Extensibility”

Question 4(a) OR [3 marks]

What is an IP address? How it is used in network?

Solution

An IP address is a numerical identifier assigned to each device connected to a network that uses Internet Protocol.

Diagram:

```
IP ADDRESS: 192.168.1.100
+[-][-][-]+[-][-][-]+[-][-][-]+[-][-][-]+
|192|168| 1 |100|  {-}-{-} Dotted decimal notation}
+[-][-][-]+[-][-][-]+[-][-][-]+[-][-][-]+
|   |   |   |
|   |   |   +[-][-][-][-} Host identifier}
|   |   +[-][-][-][-][-][-][-][-} Subnet identifier}
+[-][-][-]+[-][-][-][-][-][-][-][-][-][-][-][-} Network identifier}
```

IP Address Usage	Description
Identification	Uniquely identifies devices on a network
Routing	Determines path for data packets
Addressing	Enables sending data to specific destinations
Network Division	Allows subdivision into subnets

- **Structure:** Network portion and host portion
- **Assignment:** Static (manual) or dynamic (DHCP)
- **Versions:** IPv4 (32-bit) and IPv6 (128-bit)

Mnemonic

“IRAN” - “Identification, Routing, Addressing, Network division”

Question 4(b) OR [4 marks]

Compare FDDI and CDDI.

Solution

FDDI (Fiber Distributed Data Interface) and CDDI (Copper Distributed Data Interface) are high-speed network technologies.

Feature	FDDI	CDDI
Medium	Fiber optic cable	Copper twisted pair
Speed	100 Mbps	100 Mbps
Distance	Up to 200 km total, 2 km between stations	Up to 100 m between stations
Topology	Dual counter-rotating rings	Dual counter-rotating rings
Cost	Higher	Lower
Reliability	Very high	Moderate
Standard	ANSI X3T9.5	Same as FDDI (adapted for copper)

Diagram:

FDDI/CDDI DUAL RING TOPOLOGY:

[illegible]

- **Redundancy:** Secondary ring for fault tolerance
- **Access Method:** Token passing with timed token rotation
- **Applications:** FDDI for backbones, CDDI for workstations

Mnemonic

“FDDI Flies, CDDI Crawls” - Fiber for long distance, Copper for shorter runs

Question 4(c) OR [7 marks]

Draw and explain OSI reference model in detail.

[illegible]

Mnemonic

“All People Seem To Need Data Processing” (Layers 7 to 1)

Question 5(a) [3 marks]

What is ISO? How it works in information security?

Solution

ISO (International Organization for Standardization) develops and publishes standards including those for information security.

Question 5(c) [7 marks]

Write a short-note on 1) E-mail and 2) DNS

Solution

1) E-mail (Electronic Mail):
E-mail is a method of exchanging digital messages over a communication network.

Diagram:

E{-MAIL SYSTEM:}

SMTP

POP3/IMAP

SENDER

CLIENT

MAIL

SERVER

CLIENT

SERVER

DNS

SERVER

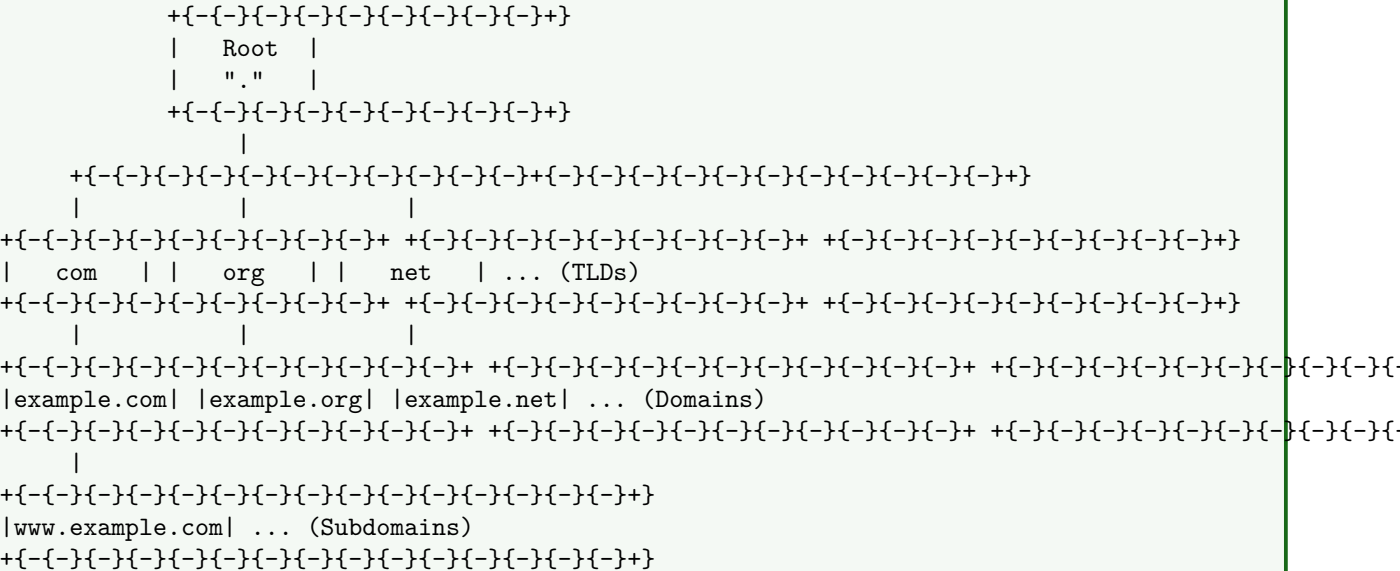
Component	Function
Mail User Agent (MUA)	Email client software used by end-users
Mail Transfer Agent (MTA)	Server software that transfers emails
Mail Delivery Agent (MDA)	Delivers email to recipient's mailbox
Protocols	SMTP (sending), POP3/IMAP (receiving)

- ## 2) DNS (Domain Name System):

DNS is a hierarchical and decentralized naming system for translating domain names to IP addresses.

Diagram:

DNS HIERARCHY:



DNS Component	Function
Root Servers	Top of DNS hierarchy
TLD Servers	Manage top-level domains (.com, .org)
Authoritative Servers	Store DNS records for specific domains
Recursive Resolvers	Query other servers to resolve domain names
DNS Records	Resource records (A, AAAA, MX, CNAME, etc.)

- **Purpose:** Map human-readable names to machine-readable addresses
- **Resolution Process:** Recursive or iterative queries through hierarchy
- **Caching:** Temporary storage of results to improve performance
- **Security:** DNSSEC provides authentication and integrity

Mnemonic

“MAPS” - “Mail needs Addresses, Protocols, and

Mnemonic

Servers” “HARD” - “Hierarchy, Addressing, Resolution, Distributed system”

Question 5(a) OR [3 marks]

What do you mean by security topology and security zone?

Solution

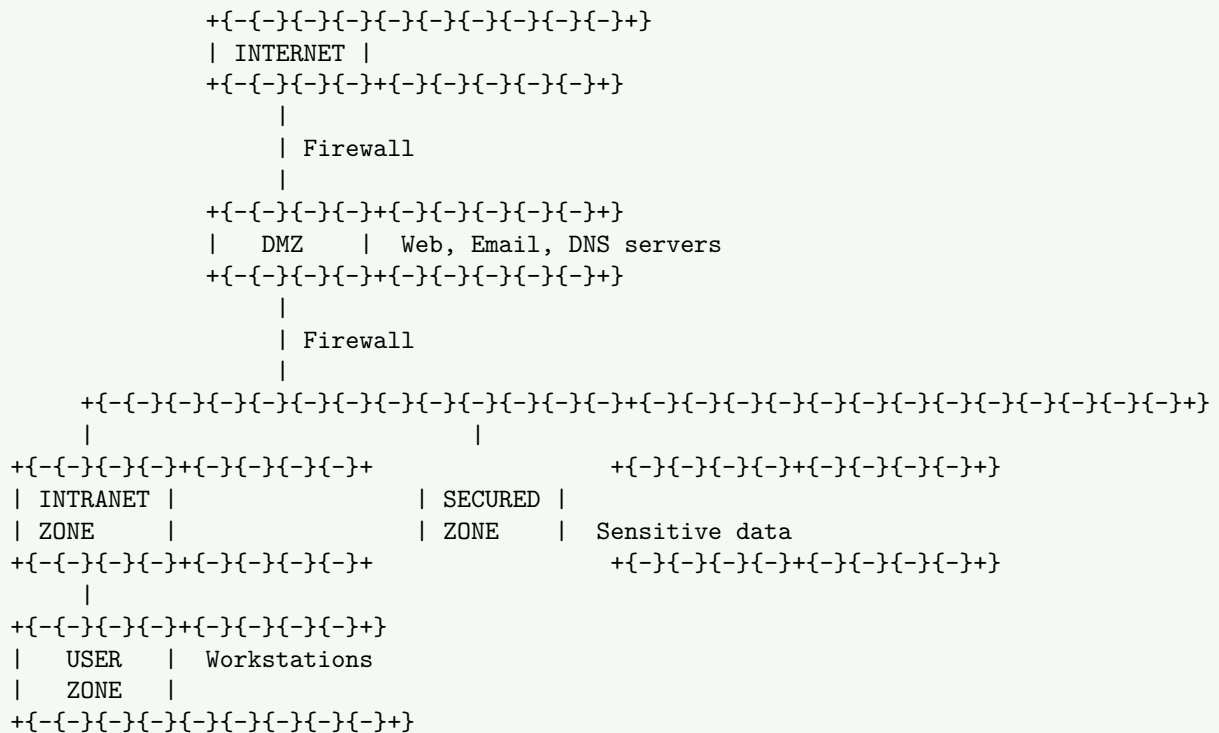
Security topology and security zones are network security concepts that organize and protect network resources.

Concept	Definition	Examples
Security Topology	Physical and logical arrangement of security controls	DMZ, Defense-in-depth

Security Zone	Segment of network with specific security requirements	DMZ, Intranet, Extranet
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Diagram:

SECURITY TOPOLOGY WITH ZONES:



- **Security Topology:** Overall security architecture design
- **Security Zones:** Logical boundaries with consistent security policies
- **Defense-in-depth:** Multiple layers of security controls

Mnemonic

“TIPS” - “Topology Isolates and Protects Systems”

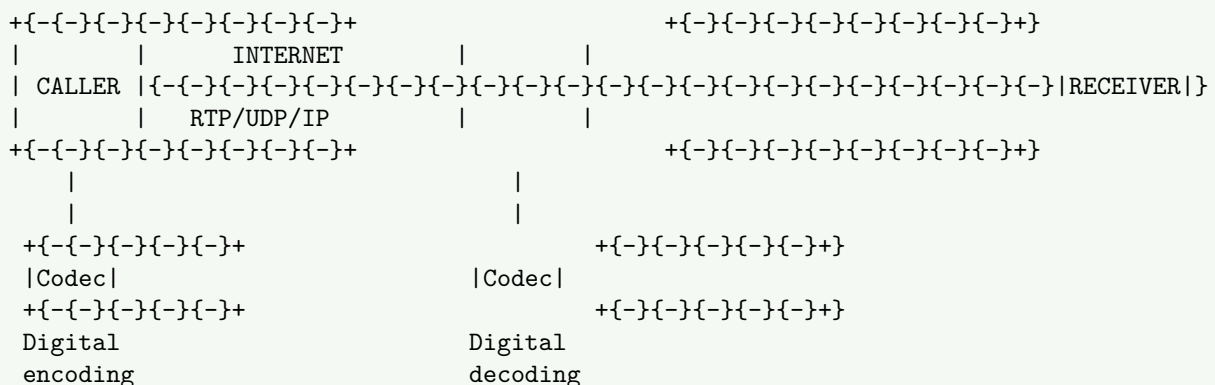
Question 5(b) OR [4 marks]

Write short-note on Voice and Video IP.

Solution

Voice and Video over IP (VoIP/Video IP) refers to technologies for transmitting voice and video communications over IP networks.

Diagram:



IPsec Modes:

Mode	Description	Use Case
Transport Mode	Protects payload only	Host-to-host communications
Tunnel Mode	Protects entire packet	Site-to-site VPNs, remote access

Security Services:

- **Authentication:** Verifies identity of communicating entities
- **Confidentiality:** Protects data from unauthorized disclosure
- **Data Integrity:** Ensures data hasn't been altered in transit
- **Replay Protection:** Prevents packet replay attacks
- **Access Control:** Limits access to network resources

Applications:

- **VPNs:** Remote access and site-to-site connections
- **Secure Routing:** Protects routing protocols
- **Secure Host-to-Host:** End-to-end security

Mnemonic

“AVID TC” - “Authentication, Verification, Integrity, Datagram protection, Transport mode, Confidentiality”