

# Mobile Computing and Networks (4351602) - Winter 2023 Solution

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## Question 1(a) [3 marks]

Differentiate between client server and peer to peer network.

### Solution

Comparison:

Table 1. Client-Server vs P2P

Parameter	Client-Server Network	Peer-to-Peer Network
Architecture	Centralized with dedicated server	Decentralized, all nodes equal
Cost	Higher due to server hardware	Lower, uses existing computers
Security	High, centralized control	Lower, distributed control
Scalability	Limited by server capacity	Better, resources increase with nodes

### Mnemonic

“CSS-P: Client-Server = Centralized Security, P2P = Peer Power”

## Question 1(b) [4 marks]

Explain ARP Protocol with its working.

### Solution

**ARP (Address Resolution Protocol)** maps IP addresses to MAC addresses in local networks.

**Working Process:**

- **Broadcast Request:** Host broadcasts ARP request with target IP
- **Cache Check:** Receiving hosts check if IP matches theirs
- **Reply Generation:** Target host sends ARP reply with MAC address
- **Cache Update:** Requesting host updates ARP table

**ARP Table Example:**

IP Address	MAC Address	TTL
192.168.1.1	00:1A:2B:3C:4D:5E	300s

### Mnemonic

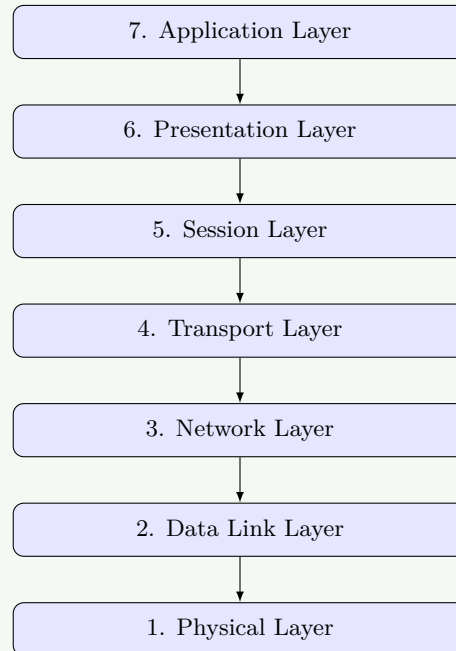
“BCRU: Broadcast, Cache, Reply, Update”

## Question 1(c) [7 marks]

Explain OSI model with diagram.

### Solution

The **OSI (Open Systems Interconnection)** model has 7 layers for network communication.



**Figure 1.** OSI Model Layers

#### Layer Functions:

- **Physical:** Bit transmission over physical medium
- **Data Link:** Frame transmission, error detection
- **Network:** Routing, IP addressing
- **Transport:** End-to-end delivery, TCP/UDP
- **Session:** Connection management
- **Presentation:** Data encryption, compression
- **Application:** User interfaces, email, web

### Mnemonic

“All People Seem To Need Data Processing”

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

What is Congestion? Explain Congestion Control.

### Solution

**Congestion** occurs when network traffic exceeds available bandwidth, causing packet delays and losses.

**Types of Congestion Control:**

**Table 2.** Congestion Control Types

Type	Method	Description
Open-Loop	Prevention	Traffic shaping before congestion
Closed-Loop	Reaction	Feedback-based adjustment

**Congestion Control Techniques:**

- **Traffic Shaping:** Regulate data transmission rate
- **Admission Control:** Limit new connections during congestion
- **Load Shedding:** Drop packets when buffers full
- **Backpressure:** Send congestion signals upstream

**Mnemonic**

“TALB: Traffic, Admission, Load, Backpressure”

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

What is Ad-hoc Network? Explain it.

**Solution**

**Ad-hoc Network** is a wireless network without fixed infrastructure where nodes communicate directly.

**Characteristics:**

- **Self-organizing:** Automatic network formation
- **Dynamic topology:** Nodes can join/leave freely
- **Multi-hop routing:** Messages relay through intermediate nodes
- **Distributed control:** No central authority

**Applications:**

- Emergency response, military operations, sensor networks

**Mnemonic**

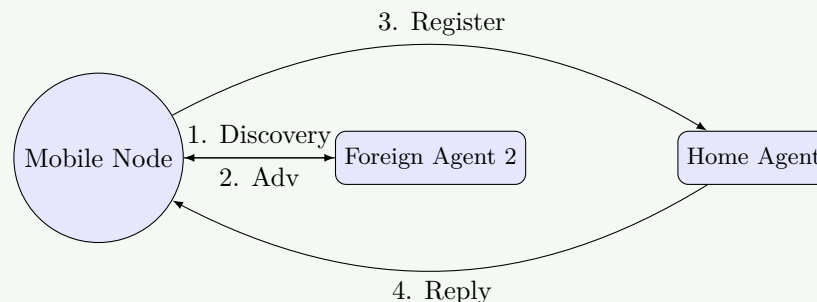
“SDMD: Self-organizing, Dynamic, Multi-hop, Distributed”

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

Explain Handover Management in Mobile IP.

**Solution**

**Handover** is the process of maintaining connectivity when a mobile node moves between networks.

**Handover Process:**

**Figure 2.** Mobile IP Handover

**Types:**

- **Hard Handover:** Break-before-make connection
- **Soft Handover:** Make-before-break connection

**Mnemonic**

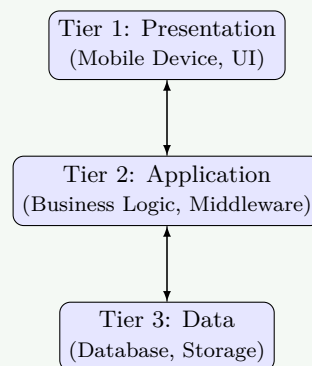
“DARU: Discovery, Advertisement, Registration, Update”

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

Explain Three tier architecture of mobile computing with diagram.

**Solution**

**Three-tier architecture** separates mobile applications into presentation, application logic, and data layers.



**Figure 3.** Three-Tier Mobile Architecture

**Layer Functions:**

- **Presentation:** User interface, mobile apps
- **Application:** Business logic, middleware services
- **Data:** Database management, storage systems

**Benefits:**

- **Scalability:** Independent layer scaling
- **Maintainability:** Separate concerns
- **Flexibility:** Technology independence

**Mnemonic**

“PAD: Presentation, Application, Data”

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

Explain Need of Wireless Network.

**Solution**

**Wireless Networks** provide connectivity without physical cables.

**Needs:**

- **Mobility:** Users can move freely while connected
- **Flexibility:** Easy network expansion and reconfiguration
- **Cost-effective:** Reduced cabling infrastructure costs

- **Accessibility:** Internet access in remote areas

**Applications:**

- Mobile communications, WiFi hotspots, IoT devices

**Mnemonic**

“MFCA: Mobility, Flexibility, Cost, Accessibility”

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

**Explain Registration, tunneling and encapsulation in mobile ip.**

**Solution****Mobile IP Components:****Table 3.** Mobile IP Concepts

Process	Description	Purpose
<b>Registration</b>	Mobile node registers with home agent	Location update
<b>Tunneling</b>	Creates virtual path between agents	Route packets
<b>Encapsulation</b>	Wraps original packet in new header	Address translation

**Process Flow:**

Original Packet → Encapsulation → Tunnel → Decapsulation → Destination

**Registration Steps:**

- Mobile node discovers foreign agent
- Sends registration request to home agent
- Home agent updates location binding

**Mnemonic**

“RTE: Registration, Tunneling, Encapsulation”

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

**What is Middleware? Write down examples of middleware and explain any one of them in detail.**

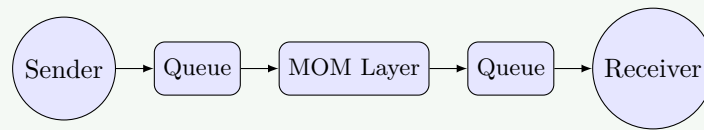
**Solution**

**Middleware** is software that connects different applications and services in distributed systems.

**Examples of Middleware:**

- Message-Oriented Middleware (MOM)
- Remote Procedure Call (RPC)
- Object Request Broker (ORB)
- Database Middleware
- Web Services

**Message-Oriented Middleware (MOM) - Detailed:**  
**Architecture:**



**Figure 4.** MOM Architecture

**Features:**

- **Asynchronous Communication:** Non-blocking message exchange
- **Reliability:** Message persistence and delivery guarantees
- **Scalability:** Handle multiple concurrent connections
- **Platform Independence:** Cross-platform communication

**Benefits:**

- Loose coupling between applications
- Improved system reliability
- Better fault tolerance

**Mnemonic**

“ARSP: Asynchronous, Reliable, Scalable, Platform-independent”

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

Give Full form for 'www'. Explain it.

**Solution**

**WWW = World Wide Web**

**Explanation:**

- **Global Information System:** Interconnected web of documents
- **HTTP Protocol:** Uses HyperText Transfer Protocol
- **URL Addressing:** Unique resource locators
- **Hyperlinks:** Navigate between web pages

**Components:**

- Web servers, browsers, HTML documents, URLs

**Mnemonic**

“GHUH: Global, HTTP, URL, Hyperlinks”

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

Explain applications of Mobile Computing.

**Solution**

**Mobile Computing Applications:**

**Table 4.** Applications

Category	Applications	Benefits
<b>Business</b>	Email, CRM, Sales	Productivity, Real-time access
<b>Healthcare</b>	Patient monitoring, Telemedicine	Remote care, Emergency response
<b>Education</b>	E-learning, Digital libraries	Flexible learning, Resource access
<b>Entertainment</b>	Gaming, Streaming, Social media	On-demand content, Connectivity

**Key Features:**

- **Location-based services:** GPS navigation, local search
- **Mobile payments:** Digital wallets, contactless transactions
- **IoT integration:** Smart home, wearable devices

**Mnemonic**

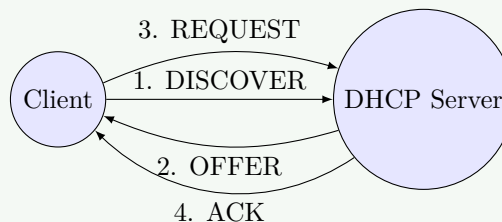
“BHEE: Business, Healthcare, Education, Entertainment”

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

Explain working of DHCP with the help of diagram and explain its advantages.

**Solution**

**DHCP (Dynamic Host Configuration Protocol)** automatically assigns IP addresses to network devices.  
**DHCP Process (DORA):**



**Figure 5.** DHCP DORA Process

**Configuration Information Provided:**

- IP address and subnet mask
- Default gateway address
- DNS server addresses
- Lease duration

**Advantages:**

- **Automatic Configuration:** No manual IP assignment
- **Centralized Management:** Single point of control
- **Efficient IP Usage:** Dynamic allocation prevents waste
- **Reduced Errors:** Eliminates manual configuration mistakes
- **Easy Maintenance:** Simple network changes

**Mnemonic**

“DORA: Discover, Offer, Request, Acknowledge”

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

Write down: Importance of HTTPS.

**Solution**

**HTTPS (HyperText Transfer Protocol Secure)** provides secure web communication.

**Importance:**

- **Data Encryption:** Protects data in transit using SSL/TLS
- **Authentication:** Verifies server identity with certificates
- **Data Integrity:** Prevents data tampering during transmission
- **Trust Building:** Increases user confidence in websites

**Security Benefits:**

- Protection against eavesdropping and man-in-the-middle attacks

**Mnemonic**

“EADT: Encryption, Authentication, Integrity, Trust”

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

**What is Bearer Network? Explain in Detail.**

**Solution**

**Bearer Network** is the underlying network infrastructure that carries data traffic between endpoints.

**Types of Bearer Networks:**

**Table 5.** Bearer Networks

Type	Technology	Characteristics
<b>Circuit-Switched</b>	Traditional telephony	Dedicated path, Guaranteed bandwidth
<b>Packet-Switched</b>	Internet, IP networks	Shared resources, Variable bandwidth
<b>Wireless</b>	Cellular, WiFi	Mobile connectivity, Air interface

**Functions:**

- **Data Transport:** Carry user data and signaling
- **Quality of Service:** Manage bandwidth and latency
- **Routing:** Direct traffic between networks
- **Network Management:** Monitor and control traffic

**Mnemonic**

“DQRN: Data transport, QoS, Routing, Network management”

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

**List out types of TCP and explain any one in detail.**

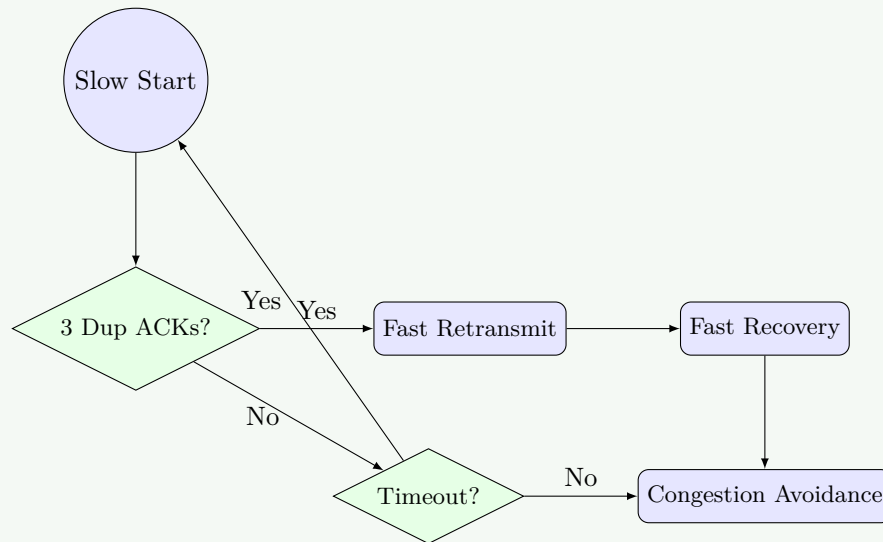
**Solution****Types of TCP:**

- Standard TCP (TCP Tahoe)
- TCP Reno
- TCP New Reno
- TCP Vegas
- TCP SACK (Selective Acknowledgment)
- TCP Cubic



**TCP Reno - Detailed Explanation:****Features:**

- **Fast Retransmit:** Retransmit lost packets quickly
- **Fast Recovery:** Avoid slow start after fast retransmit
- **Congestion Avoidance:** Linear increase in congestion window
- **Duplicate ACK Detection:** Identify packet loss

**Congestion Control Algorithm:****Figure 6.** TCP Reno phases**Advantages:**

- **Better Performance:** Faster recovery from packet loss
- **Efficiency:** Maintains higher throughput
- **Fairness:** Equitable bandwidth sharing

**Mnemonic**

“FFCE: Fast retransmit, Fast recovery, Congestion avoidance, Efficiency”

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

Define WLAN. List out types of WLAN.

**Solution**

**WLAN (Wireless Local Area Network)** provides wireless connectivity within a limited area.

**Types of WLAN:**

- **Infrastructure Mode:** Uses access points for connectivity
- **Ad-hoc Mode:** Direct device-to-device communication
- **Mesh Networks:** Multi-hop wireless connectivity
- **Hybrid Networks:** Combination of infrastructure and ad-hoc

**Standards:**

- IEEE 802.11a/b/g/n/ac/ax (WiFi 6)

**Mnemonic**

“IAMH: Infrastructure, Ad-hoc, Mesh, Hybrid”

## Question 4(b) [4 marks]

What is Routing? Explain types of Routing.

### Solution

**Routing** is the process of selecting paths for data packets across networks.

**Types of Routing:**

**Table 6.** Routing Types

Type	Method	Characteristics
<b>Static Routing</b>	Manual configuration	Fixed paths, No automatic updates
<b>Dynamic Routing</b>	Automatic updates	Adaptive paths, Real-time changes
<b>Default Routing</b>	Catch-all route	Used when no specific route exists
<b>Distance Vector</b>	Hop count based	RIP protocol, Simple implementation
<b>Link State</b>	Network topology	OSPF protocol, Faster convergence

**Dynamic Routing Advantages:**

- **Automatic adaptation** to network changes
- **Load balancing** across multiple paths
- **Fault tolerance** with alternate routes

### Mnemonic

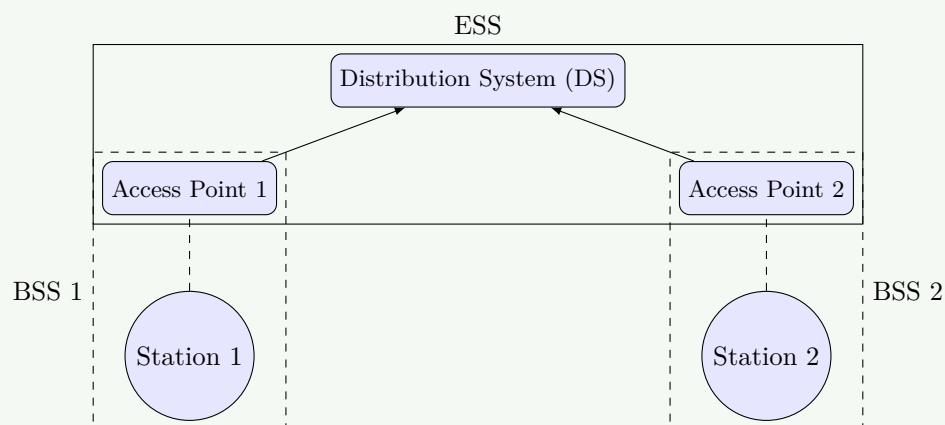
“SDDL: Static, Dynamic, Default, Link-state”

## Question 4(c) [7 marks]

Explain architecture of WLAN.

### Solution

**WLAN Architecture Components:**



**Figure 7.** WLAN Architecture

**Architecture Elements:**

- **Station (STA):** Wireless client devices
- **Access Point (AP):** Central wireless hub
- **Basic Service Set (BSS):** Single AP coverage area
- **Extended Service Set (ESS):** Multiple interconnected APs

- **Distribution System (DS):** Backend network connecting APs
- WLAN Topologies:**
- **Infrastructure Mode:** Centralized through AP
  - **Ad-hoc Mode:** Direct peer-to-peer communication
  - **Mesh Topology:** Multi-hop wireless connections

#### Mnemonic

“SABED: Station, Access Point, BSS, ESS, Distribution System”

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

Define WPAN. List out applications of WPAN.

#### Solution

**WPAN (Wireless Personal Area Network)** connects devices within personal space (typically 10 meters).  
**Applications of WPAN:**

- **Device Synchronization:** Phone to computer data transfer
- **Audio Streaming:** Wireless headphones, speakers
- **Input Devices:** Wireless keyboard, mouse
- **Healthcare:** Medical sensors, fitness trackers
- **Smart Home:** IoT device control

**Technologies:**

- Bluetooth, Zigbee, NFC, infrared

#### Mnemonic

“DSAHS: Device sync, Streaming, Audio, Healthcare, Smart home”

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

Explain working of IMAP Protocol.

#### Solution

**IMAP (Internet Message Access Protocol)** manages email on mail servers.

**IMAP Working Process:**

**Table 7.** IMAP Process

Step	Action	Description
Connection	Client connects to server	Establish TCP connection on port 143/993
Authentication	Login credentials	Username/password verification
Mailbox Selection	Choose folder	Select INBOX or other folders
Message Operations	Read/Delete/Flag	Manipulate messages on server

**IMAP vs POP3:**

- **Server Storage:** Messages remain on server
- **Multi-device Access:** Sync across devices
- **Folder Management:** Server-side folder structure
- **Partial Download:** Headers first, body on demand

**Mnemonic**

“CAMS: Connection, Authentication, Mailbox, Storage”

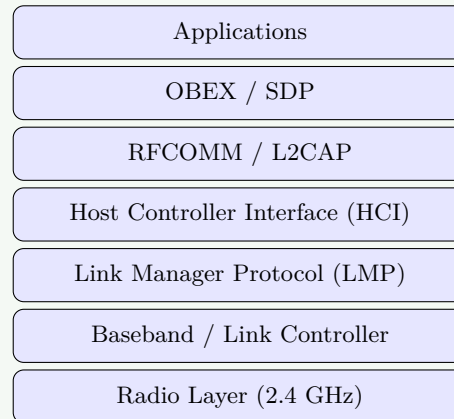
**Question 4(c OR) [7 marks]**

Explain Bluetooth technology with a figure of its protocol stack.

**Solution**

**Bluetooth** is a short-range wireless communication technology for personal area networks.

**Bluetooth Protocol Stack:**



**Figure 8.** Bluetooth Protocol Stack

**Layer Functions:**

- **Radio Layer:** 2.4 GHz ISM band, frequency hopping
- **Baseband:** Timing, access control, packet formats
- **LMP:** Link establishment, security, power management
- **L2CAP:** Packet segmentation, protocol multiplexing
- **RFCOMM:** Serial port emulation over wireless
- **SDP:** Service discovery protocol
- **Applications:** File transfer, audio streaming, HID

**Mnemonic**

“RBLSRA: Radio, Baseband, LMP, SDP, RFCOMM, Applications”

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

What is 4G? List out Features of 4G.

**Solution**

**4G (Fourth Generation)** is a mobile communication standard providing high-speed wireless internet.

**Features of 4G:**

- **High Data Speed:** Up to 100 Mbps mobile, 1 Gbps stationary
- **All-IP Network:** Packet-switched architecture
- **Low Latency:** Reduced delay for real-time applications
- **Quality of Service:** Guaranteed service levels
- **Global Roaming:** Worldwide compatibility

**Technologies:**

- LTE (Long Term Evolution), WiMAX

**Mnemonic**

“HALQG: High-speed, All-IP, Low latency, QoS, Global roaming”

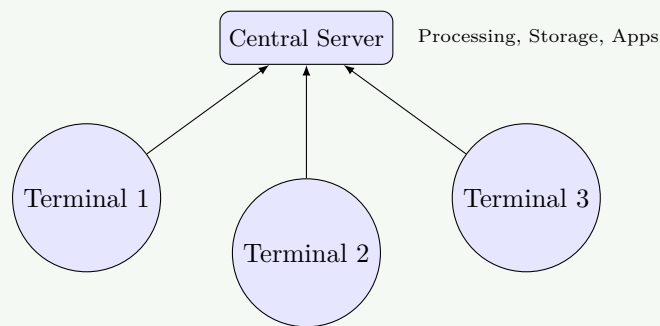
**Question 5(b) [4 marks]**

**Explain Centralized Computing.**

**Solution**

**Centralized Computing** processes all data and applications on a central server.

**Architecture:**



**Figure 9.** Centralized Computing

**Characteristics:**

- **Single Point of Control:** All processing at central location
- **Thin Clients:** Minimal local processing capability
- **Shared Resources:** CPU, memory, storage centrally managed
- **Network Dependent:** Requires reliable network connectivity

**Advantages:**

- **Security:** Centralized data protection
- **Management:** Easier system administration
- **Cost:** Lower client-side hardware costs

**Mnemonic**

“SSNG: Single control, Shared resources, Network dependent, Greater security”

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

**What is ipv4 addressing scheme? Explain with a neat and clean diagram with its working.**

**Solution**

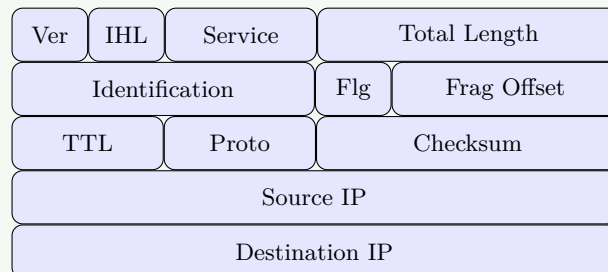
**IPv4 (Internet Protocol version 4)** uses 32-bit addresses for network identification.

**IPv4 Address Structure:**



**Figure 10. IPv4 Structure****IPv4 Address Classes:****Table 8. Address Classes**

Class	Range	Net Bits	Host Bits	Subnet Mask
<b>A</b>	1-126	8	24	255.0.0.0
<b>B</b>	128-191	16	16	255.255.0.0
<b>C</b>	192-223	24	8	255.255.255.0
<b>D</b>	224-239	Multicast	-	-
<b>E</b>	240-255	Exp.	-	-

**IPv4 Packet Header:****Figure 11. IPv4 Header****Mnemonic**

“Class A-E, Header: Version IHL TOS Length ID Flags TTL Protocol Checksum Source Dest”

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

What is 5G? List out Features of 5G.

**Solution**

**5G (Fifth Generation)** is the latest mobile communication standard with enhanced capabilities.

**Features of 5G:**

- **Ultra-High Speed:** Up to 10 Gbps data rates
- **Ultra-Low Latency:** Less than 1ms response time
- **Massive Connectivity:** 1 million devices per km<sup>2</sup>
- **Network Slicing:** Virtual dedicated networks
- **Enhanced Mobile Broadband:** Improved user experience

**Key Technologies:**

- Millimeter wave, Massive MIMO, Beamforming

**Mnemonic**

“UUMNE: Ultra-speed, Ultra-low latency, Massive connectivity, Network slicing, Enhanced broadband”

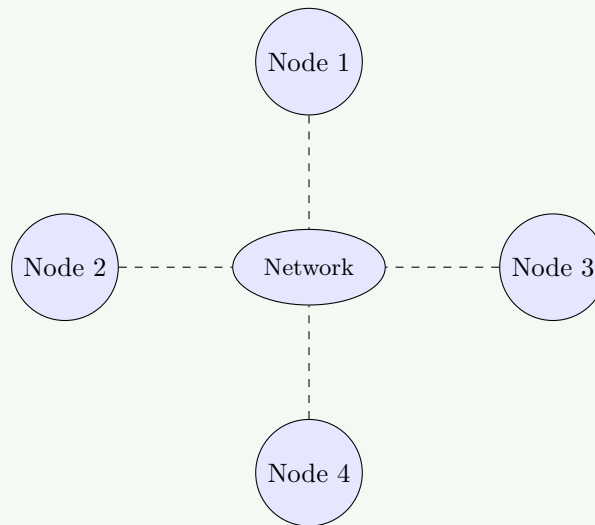
**Question 5(b OR) [4 marks]**

Explain Distributed Computing

**Solution**

**Distributed Computing** spreads processing across multiple interconnected computers.

**Architecture:**



**Figure 12.** Distributed System

**Characteristics:**

- **Resource Sharing:** Distributed processing and storage
- **Scalability:** Add more nodes to increase capacity
- **Fault Tolerance:** System continues if some nodes fail
- **Location Transparency:** Users unaware of resource locations

**Advantages:**

- **Reliability:** No single point of failure
- **Performance:** Parallel processing capabilities
- **Cost-effectiveness:** Use commodity hardware

**Mnemonic**

“RSFL: Resource sharing, Scalability, Fault tolerance, Location transparency”

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

**Explain Data Link Layer Protocol.**

**Solution**

**Data Link Layer** provides reliable data transfer between adjacent network nodes.

**Functions:**

- **Framing:** Organize bits into frames
- **Error Detection:** Identify transmission errors
- **Error Correction:** Fix detected errors
- **Flow Control:** Manage data transmission rate
- **Access Control:** Coordinate shared media access

**Frame Structure:**



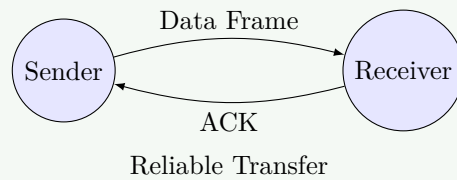
**Figure 13.** Frame Structure

**Error Detection Methods:**

- Parity Check
- Checksum
- CRC (Cyclic Redundancy Check)

**Flow Control Protocols:**

- Stop-and-Wait
- Sliding Window
- Go-Back-N ARQ
- Selective Repeat ARQ

**Working Process:****Figure 14.** Data Link Protocol**Mnemonic**

“FECFA: Framing, Error detection, Correction, Flow control, Access control”