

**Unit I****Chapter 1 : Introduction to Computer Networks****1-1 to 1-37**

Syllabus : Definition, **Types of Networks** : Local Area Networks (LAN), Metropolitan Area Networks (MAN), Wide Area Networks (WAN), Wireless networks, Networks software, Protocol, Design issues for the network layers.
Network Models : The OSI reference model, TCP/IP model, Network topologies, Types of transmission medium.
Network Architectures : Client-Server, Peer to Peer, Hybrid.

1.1	Introduction	1-2	1.8.3	Disadvantages of Layered Architecture	1-13
1.1.1	Computer Networks	1-2	1.8.4	Data Transfer	1-13
1.1.2	Hardware and Software	1-2	1.9	Network Architecture	1-13
1.1.3	Protocol	1-2	1.9.1	Virtual Communication between Layers	1-13
1.2	Network Topology	1-2	1.10	Design Issues for the Layers	1-14
1.2.1	Bus Topology	1-2	1.11	Connection Oriented and Connectionless Services	1-15
1.2.2	Ring Topology	1-3	1.11.1	Comparison of C.O and C.L. Services	1-16
1.2.3	Star Topology	1-4	1.12	Interface and Services	1-16
1.2.4	Mesh Topology	1-5	1.12.1	Service	1-17
1.2.5	Tree Topology	1-6	1.12.2	Protocol	1-17
1.2.6	Logical Topology	1-6	1.13	Reference Models	1-17
1.2.7	Hybrid Topology	1-6	1.14	OSI Model	1-18
1.3	Types of Communication	1-7	1.14.1	Layered Architecture	1-18
1.4	Network Hardware	1-7	1.14.2	Communication in OSI Model	1-19
1.4.1	Transmission Technology	1-7	1.14.3	Peer to Peer Processes	1-19
1.4.2	Network Scale	1-7	1.14.4	Organization of the Layers	1-19
1.5	Types of Network	1-8	1.14.5	Layer Details of OSI Model	1-20
1.5.1	Local Area Networks (LAN)	1-8	1.14.6	Exchange of Information in OSI Model	1-22
1.5.2	Metropolitan Area Network (MAN)	1-9	1.14.7	Merits of OSI Reference Model	1-23
1.5.3	Wide Area Network (WAN)	1-9	1.14.8	Demerits of OSI Model	1-23
1.5.4	Wireless Networks	1-10	1.15	The TCP / IP Reference Model	1-23
1.5.5	Comparison of LAN, WAN and MAN	1-10	1.15.1	Layer Details of TCP/IP	1-24
1.6	Network Classification by their Component Role	1-10	1.15.2	Description of TCP/IP Model	1-24
1.6.1	Peer-to-Peer Networks	1-10	1.15.3	Layered Architecture	1-25
1.6.2	Client / Server Network	1-11	1.15.4	Logical Connections in the TCP / IP	1-25
1.7	Layered Tasks	1-12	1.15.5	Data Unit Created by Every Layer	1-26
1.8	Network Software	1-12	1.16	Detailed Description of Layers	1-26
1.8.1	Protocol Hierarchies	1-12	1.16.1	TCP/IP Physical Layer	1-26
1.8.2	Reasons for having Layered Protocols	1-13	1.16.2	TCP/IP Data Link Layer	1-27
			1.16.3	TCP / IP Network Layer	1-27
			1.16.4	TCP/IP Transport Layer	1-28
			1.16.5	TCP/IP Application Layer	1-29
			1.16.6	Merits of TCP/IP model	1-29
			1.16.7	Demerits of TCP / IP Model	1-30
			1.16.8	Hybrid (Internet) Reference Model	1-30
			1.16.9	Comparison of Models	1-30
			1.17	Transmission Media	1-31
			1.17.1	Classification of Transmission Media	1-31
			1.18	Twisted Pair Cables	1-31



1.18.1	UTP (Unshielded Twisted Pair)	1-31
1.18.2	STP (Shielded Twisted Pair)	1-32
1.19	Co-axial Cables	1-32
1.20	Optical Fiber Cables	1-33
1.20.1	Modes of Propagation	1-33
1.20.2	Single Mode Fibers	1-34
1.20.3	Multimode Fibers	1-34
1.20.4	Characteristics of Optical Fiber Cables ...	1-34
1.20.5	Advantages of Optical Fibers	1-34
1.20.6	Applications	1-34
1.20.7	Comparison of Wired Media	1-35
1.21	Wireless Media	1-35
1.22	Types of Wireless Media	1-35
1.22.1	Radio Wave Transmission Systems	1-35
1.22.2	Microwave Transmission System	1-35
1.22.3	Comparison of Wired and Wireless Media	1-36
1.23	University Questions and Answers	1-37
	• Review Questions.....	1-36

Unit I

Chapter 2 : Network Devices & Line Coding 2-1 to 2-14

Syllabus : Network Devices : Bridge, Switch, Router, Gateway, Access point. **Line Coding Schemes :** Manchester and Differential Manchester encodings, Frequency Hopping (FHSS) and Direct Sequence Spread Spectrum (DSSS).

2.1	Network Devices	2-2
2.1.1	Hubs	2-3
2.1.2	Repeaters	2-3
2.1.3	Bridges	2-4
2.1.4	Routers	2-5
2.1.5	Gateways	2-6
2.1.6	Switches	2-6
2.1.7	Wireless Access Point (AP)	2-7
2.1.8	Comparison of Networking Devices	2-8
2.2	Line Coding	2-8
2.2.1	Properties of Line Codes	2-8
2.2.2	Manchester Encoding	2-9
2.2.3	Differential Manchester Encoding	2-9
2.3	Spread Spectrum Modulation	2-11

2.3.1	Direct Sequence Spread Spectrum (DSSS)	2-12
2.3.2	Frequency Hop Spread Spectrum (FH-SS)	2-13
	• Review Questions	2-14

Unit II

Chapter 3 : Data Link Layer

3-1 to 3-36

Syllabus : Introduction, Functions. **Design issues :** Services to network layer, Framing. **ARQ strategies :** Error detection and correction, Parity bits, Hamming codes (11/12-bits) and CRC, **Flow control protocols :** Unrestricted simplex, Stop and wait, Sliding window protocol, **WAN connectivity :** PPP and HDLC.

3.1	Introduction	3-2
3.1.1	Position of Data Link Layer	3-2
3.2	Data Link Layer Design Issues	3-2
3.3	Services Provided to Network Layer	3-3
3.3.1	Types of Services Provided	3-3
3.3.2	Unacknowledged Connectionless Service	3-3
3.3.3	Acknowledged Connectionless Service	3-3
3.3.4	Acknowledged Connection Oriented Service	3-3
3.4	Framing	3-4
3.4.1	Framing Methods	3-4
3.4.2	Character Count	3-4
3.4.3	Starting and Ending Character with Character Stuffing	3-4
3.4.4	Character Stuffing	3-5
3.4.5	Starting and Ending Flags, with Bit Stuffing	3-5
3.4.6	Physical Layer Coding Violations	3-6
3.5	Error Control	3-6
3.5.1	Function of a Timer	3-6
3.6	Error Detection and Correction	3-7
3.6.1	Encoding and Decoding	3-7
3.6.2	Redundancy	3-7
3.6.3	Classification of Error Control Techniques	3-7
3.6.4	Error Detection Methods	3-8
3.6.5	Parity Checking	3-8
3.6.6	Checksum Error Detection	3-9



3.6.7	Two Dimensional Parity Check (Block Parity)	3-10
3.6.8	Cyclic Redundancy Check (CRC)	3-10
3.7	Error Correction	3-13
3.7.1	Classification of Error-correcting Codes	3-14
3.7.2	Linear Block Codes	3-14
3.7.3	Hamming Codes	3-14
3.7.4	ARQ Technique	3-17
3.8	Flow Control	3-17
3.9	Elementary Data Link Protocols	3-18
3.9.1	An Unrestricted Simplex Protocol	3-18
3.9.2	A Simplex Stop and Wait Protocol	3-18
3.9.3	A Simplex Protocol for Noisy Channel	3-19
3.9.4	Piggybacking	3-20
3.10	Sliding Window Protocols	3-20
3.10.1	A One Bit Sliding Window Protocol (Stop and Wait ARQ)	3-22
3.10.2	A Protocol using GO Back n	3-24
3.10.3	Pipelining	3-26
3.10.4	Selective Repeat ARQ	3-26
3.10.5	Protocol Performance	3-27
3.10.6	Comparison of Sliding Window Protocols	3-28
3.11	High Level Data Link Control (HDLC) Protocol	3-29
3.11.1	Frame Structure in HDLC	3-30
3.11.2	Frame Types in HDLC	3-30
3.11.3	Transparency in HDLC	3-32
3.11.4	Bit Stuffing	3-32
3.12	Ways of Accessing the Internet	3-33
3.13	SLIP-Serial Line IP	3-34
3.14	Point-to-Point Protocol (PPP)	3-34
3.14.1	Services Provided by PPP	3-34
3.14.2	Frame Format of PPP	3-34
3.14.3	Transition Phases	3-35
3.14.4	Multiplexing	3-35
3.14.5	PPP Stack	3-36
3.14.6	Comparison of HDLC and PPP	3-36
	• Review Questions.....	3-36

Unit II**Chapter 4 : Medium Access Control 4-1 to 4-45**

Syllabus : MAC sub layer : Multiple access protocols : Pure and slotted ALOHA, CSMA, WDMA, CSMA/CD, CSMA/CA, Binary exponential Back-off algorithm, **Introduction to Ethernet : IEEE 802.3, IEEE 802.11 a/b/g/n and IEEE 802.15 and IEEE 802.16 standards.**

4.1	Introduction	4-2
4.1.1	MAC and LLC Sublayers	4-2
4.2	The Channel Allocation Problem	4-2
4.2.1	Static Channel Allocation	4-3
4.2.2	Dynamic Channel Allocation	4-3
4.2.3	Comparison between Static and Dynamic Channel Allocation	4-4
4.3	Multiple Access	4-4
4.3.1	Random Access	4-4
4.3.2	Evolution of Random Access Methods	4-4
4.3.3	Classification of Multiple Access Protocols	4-4
4.4	Multiple Access ALOHA System	4-5
4.4.1	Pure ALOHA	4-5
4.4.2	Efficiency of an ALOHA System	4-6
4.4.3	Slotted ALOHA	4-7
4.4.4	Comparison of Pure and Slotted ALOHA	4-8
4.5	Carrier Sense Multiple Access (CSMA)	4-10
4.5.1	Carrier Sense Multiple Access/Collision Detection (CSMA/CD)	4-10
4.5.2	CSMA/CD Procedure	4-11
4.5.3	CSMA/CA	4-12
4.6	Collision Free Protocols	4-12
4.6.1	Limited Contention Protocols	4-13
4.7	Binary Exponential Back off Algorithm	4-14
4.7.1	Wavelength Division Multiplexing (WDM)	4-14
4.7.2	Wavelength Division Multiple Access Protocols (WDMA)	4-15
4.8	Wired LANs Ethernet Protocol	4-15
4.8.1	Ethernet	4-16
4.8.2	Traditional Ethernet	4-17
4.8.3	Fast Ethernet	4-17
4.8.4	Gigabit Ethernet	4-17



4.9	IEEE Standards	4-17	4.17.5	Point Co-ordinate Function (PDF)	4-35
4.10	Traditional Ethernet (IEEE 802.3)	4-18	4.17.6	Fragmentation	4-36
4.10.1	Traditional Ethernet Frame	4-18	4.18	802.11 Frame Format	4-36
4.10.2	Frame Length	4-18	4.18.1	Comparison of Ethernet and WLAN	4-37
4.10.3	Addressing	4-18	4.18.2	Advantages of WLAN	4-38
4.10.4	Types of Addresses	4-19	4.18.3	Limitations of WLAN	4-38
4.10.5	Physical Properties of Ethernet	4-19	4.18.4	Applications of Wireless LAN	4-38
4.10.6	Physical Layer Implementation of Standard Ethernet	4-19	4.19	Wireless PAN (WPAN) IEEE 802.15	4-38
4.11	Fast Ethernet	4-20	4.20	Bluetooth (WPAN) (IEEE 802.15.1)	4-39
4.11.1	Autonegotiation	4-21	4.20.1	Features of Bluetooth	4-39
4.11.2	Physical Layer Implementation	4-21	4.20.2	Bluetooth Devices and Frequency Band	4-39
4.12	Gigabit Ethernet	4-21	4.20.3	Principle of Bluetooth	4-40
4.12.1	Physical Layer Implementation	4-22	4.21	Bluetooth Architecture	4-40
4.12.2	Ten Gigabit Ethernet	4-22	4.21.1	Piconets	4-40
4.12.3	Comparison of Ethernet	4-22	4.21.2	Scatternets	4-41
4.13	Wireless LANs	4-23	4.21.3	Frame Format	4-41
4.13.1	IEEE Standards	4-23	4.21.4	Bluetooth Advantages	4-42
4.13.2	Wi-Fi	4-23	4.21.5	Bluetooth Limitations	4-42
4.13.3	ISM Band	4-23	4.21.6	Applications of Bluetooth	4-42
4.14	Wi-Fi (IEEE 802.11)	4-23	4.21.7	Comparison of WPAN and WLAN	4-42
4.14.1	Classification of WLANs	4-24	4.21.8	Comparison of B.T. and WLAN	4-43
4.14.2	The IEEE 802.11 Protocol Stack	4-24	4.22	Wi-Max (IEEE 802.16)	4-43
4.14.3	802.11 Network Architecture	4-25	4.22.1	IEEE Project 802.16	4-44
4.14.4	Types of Stations	4-26	4.22.2	Wi-Max Services	4-44
4.15	The Physical Layer	4-26	4.22.3	Spectrum Allocation	4-44
4.15.1	IEEE 802.11 FHSS	4-27	4.22.4	802.16 Frame Format	4-44
4.15.2	IEEE 802.11 DSSS	4-28	4.22.5	Applications of Wi-Max	4-44
4.15.3	IEEE 802.11 Infrared	4-29	4.22.6	Comparison of WLAN and Wi-Max	4-45
4.15.4	IEEE 802.11 a OFDM	4-30	• Review Questions	4-45	
4.15.5	IEEE 802.11 b HR-DSSS	4-31			
4.15.6	IEEE 802.11 g OFDM	4-31			
4.15.7	IEEE 802.11 n OFDM	4-31			
4.16	Problems in Wireless LAN	4-31			
4.16.1	Hidden Terminal Problem	4-31			
4.16.2	Exposed Station Problem	4-32			
4.17	MAC Sublayer	4-33			
4.17.1	RTS and CTS Mechanism	4-33			
4.17.2	Different Time Intervals	4-33			
4.17.3	Distributed Co-ordination Function (DCF)	4-34			
4.17.4	Hidden Station Problem	4-35			

Unit III

Chapter 5 : Network Layer

5-1 to 5-64

Syllabus : Introduction : Functions of Network layer.
Switching Techniques : Circuit switching, Message Switching, Packet Switching. **IP Protocol** : Classes of IP (Network addressing), IPv4, IPv6, Network Address Translation, Sub-netting, CIDR, ICMP, Mobile IP.

5.1	Network Layer	5-2
5.1.1	Network Layer Duties	5-2
5.2	Network Layer Design Issues	5-2
5.2.1	Store and Forward Packet Switching	5-3



5.2.2	Services Provided to the Transport Layer	5-3	5.11	Classful Addressing	5-18
5.2.3	Implementation of Connectionless Service	5-3	5.11.1	IPv4 Address Classes	5-18
5.2.4	Implementation of Connection-Oriented Service	5-4	5.11.2	Formats of Various Address Classes	5-19
5.2.5	Internal Organization of the Network Layer	5-5	5.11.3	How to Recognize Address Classes ?	5-20
5.2.6	Comparison of Virtual Circuit and Datagram Subnets	5-5	5.11.4	Two Level Addressing	5-20
5.3	Routing and Forwarding	5-5	5.11.5	Extracting Information in a Block	5-21
5.3.1	Routing	5-5	5.11.6	Network Address	5-21
5.3.2	Forwarding	5-6	5.11.7	Network Mask or Default Mask	5-22
5.4	Other Services	5-6	5.11.8	Default Masks for Different Classes	5-22
5.4.1	Error Control	5-6	5.11.9	Finding Network Address using Default Mask	5-22
5.4.2	Flow Control	5-6	5.11.10	Three Level Addressing Subnetting	5-23
5.4.3	Congestion Control	5-6	5.11.11	Special IP Addresses	5-23
5.4.4	Quality of Service (QoS)	5-7	5.11.12	Limitations of IPv4	5-24
5.4.5	Security	5-7	5.11.13	Classless Addressing	5-24
5.5	Switching	5-7	5.11.14	Supernetting	5-24
5.5.1	Switching Methods	5-7	5.11.15	Registered and Unregistered Addresses	5-25
5.5.2	Circuit Switching	5-7	5.11.16	Solved Examples	5-25
5.6	Message Switching	5-9	5.12	Classless Addressing in IPv4	5-29
5.7	Packet Switching	5-10	5.12.1	Variable Length Blocks	5-29
5.7.1	Datagram Approach Connectionless Service	5-10	5.12.2	The Slash Notation (CIDR Notation)	5-30
5.7.2	Virtual Circuit Approach Connection Oriented Service	5-11	5.12.3	Network Mask	5-31
5.7.3	Comparison of Message, Circuit and Packet Switching	5-12	5.12.4	Extracting the Block Information	5-31
5.7.4	Network Layer Congestion	5-13	5.12.5	Block Allocation	5-33
5.8	Congestion Control	5-14	5.12.6	Relation to Classful Addressing	5-33
5.8.1	Need of Congestion Control	5-14	5.12.7	Subnetting	5-33
5.8.2	Causes of Congestion	5-14	5.12.8	Designing Subnets	5-33
5.8.3	Difference between Congestion Control and Flow Control	5-15	5.12.9	Finding Information about Each Network	5-34
5.8.4	Principle of Congestion Control	5-15	5.12.10	Address Aggregation	5-34
5.9	Congestion Prevention Policies	5-16	5.13	Special Addresses	5-38
5.10	IPv4 Addresses	5-17	5.13.1	Special Blocks	5-38
5.10.1	Uniqueness of IP Addresses	5-18	5.13.2	All Zeros Address	5-39
5.10.2	Address Space	5-18	5.13.3	All one Address-Limited Broadcast Address	5-39
5.10.3	Notation	5-18	5.13.4	Loopback Address	5-39
5.10.4	IPv4 Address Format	5-18	5.13.5	Private Addresses	5-39
			5.13.6	Multicast Addresses	5-39
			5.13.7	Special Addresses in Each Block	5-39
			5.13.8	Network Address	5-39
			5.13.9	Direct Broadcast Address	5-39



5.14	Internet Protocol Version 4 (IPv4)	5-39	5.21.3	Abbreviation	5-59
5.14.1	Position of IP	5-40	5.22	IPv6 Packet Format	5-60
5.14.2	Internet Protocol (IP)	5-40	5.22.1	Payload	5-61
5.14.3	Various Network Layer Protocols	5-40	5.22.2	NAT – Network Address Translation	5-61
5.14.4	IPv4 Header Format	5-41	5.22.3	Extension Headers	5-62
5.15	Fragmentation.....	5-45	5.22.4	Comparison between IPv4 and IPv6	5-63
5.15.1	Transparent Strategy	5-45	5.23	University Questions and Answers	5-64
5.15.2	Non-transparent Strategy	5-46	• Review Questions	5-64	
5.15.3	Maximum Transfer Unit (MTU)	5-46	Unit III		
5.15.4	Fields Related to Fragmentation	5-47	<hr/>		
5.16	ICMPv4	5-47	Chapter 6 : Network Layer Protocols 6-1 to 6-46		
5.16.1	ICMP Encapsulation	5-47	Syllabus : Network Layer protocols : ARP, RARP, IGMP. Network Routing and Algorithms : Static routing, Dynamic routing, Distance vector routing, Link state routing, Path Vector. Routing Protocols : RIP, OSPF, BGP, MPLS, Routing in MANET : AODV, DSR.		
5.16.2	ICMP Messages	5-48	6.1	Network Layer Protocols	6-2
5.16.3	Message Format	5-48	6.1.1	Why IP Address ?	6-2
5.17	Error Reporting Messages in ICMPv4	5-48	6.2	ARP (Address Resolution Protocol)	6-3
5.17.1	General Format of Error Reporting Messages.....	5-49	6.2.1	Mapping of IP Address into a MAC Address	6-3
5.17.2	Destination Unreachable	5-49	6.2.2	ARP Operation	6-4
5.17.3	Source Quench Error Message	5-50	6.2.3	Mapping Physical Address to Logical Address	6-4
5.17.4	Time Exceeded Error Message	5-50	6.2.4	ARP Cache Memory	6-4
5.17.5	Parameter Problem Error Message	5-50	6.2.5	ARP Packet Format	6-5
5.17.6	Redirection Error Message	5-51	6.2.6	Encapsulation	6-5
5.18	Query Messages (ICMPv4)	5-51	6.2.7	Operation of ARP on Internet	6-5
5.18.1	Echo Request and Reply	5-52	6.2.8	Four Different Cases	6-6
5.18.2	Timestamp Request and Reply	5-52	6.3	The Reverse Address Resolution (RARP) Protocol	6-7
5.18.3	Deprecated Messages	5-53	6.4	Routing	6-8
5.18.4	Checksum	5-53	6.4.1	Types of Routing	6-8
5.19	Mobile IP	5-53	6.4.2	Intra and Interdomain Routing	6-8
5.19.1	Addressing	5-54	6.4.3	Unicast Routing	6-9
5.19.1.1	Addressing in Stationary Hosts	5-54	6.4.4	Broadcast Routing	6-9
5.19.1.2	Mobile Hosts	5-54	6.4.5	Multicast Routing	6-10
5.19.2	Agents	5-54	6.5	Routing Algorithms	6-10
5.19.3	Three Phases	5-55	6.5.1	Desired Properties of a Routing Algorithm	6-11
5.19.4	Transparency	5-57	6.5.2	Types of Routing Algorithms	6-11
5.19.5	Inefficiency in Mobile IP	5-57	6.5.3	Optimality Principle	6-11
5.19.6	Remedy	5-58	6.6	Static Algorithms	6-11
5.20	IPv6 (Next Generation IP)	5-58			
5.20.1	Advantages of IPv6	5-58			
5.21	IPv6 Addressing	5-58			
5.21.1	IPv6 Address	5-59			
5.21.2	Notations	5-59			



6.6.1	Shortest Path Routing	6-11	6.16.5	OSPF Packet Types	6-31
6.6.2	Flooding	6-12	6.16.6	Comparison between RIP and OSPF	6-32
6.7	Dynamic Routing Algorithms	6-12	6.17	Border Gateway Protocol (BGP)	6-33
6.8	Distance Vector Routing Algorithm	6-13	6.17.1	Types of Autonomous Systems	6-33
6.8.1	Disadvantages	6-14	6.17.2	CIDR	6-33
6.8.2	Looping in Distance Vector Routing Protocol	6-14	6.17.3	Path Attributes	6-33
6.8.3	Count to Infinity Problem	6-15	6.17.4	Types of Attributes	6-33
6.8.4	Split Horizon Algorithm	6-16	6.18	BGP Sessions	6-34
6.9	Link State Routing	6-17	6.18.1	External and Internal BGP	6-34
6.9.1	Comparison of Link State Routing and Distance Vector Routing	6-18	6.18.2	Types of Messages	6-34
6.10	Hierarchical Routing	6-18	6.18.3	Encapsulation	6-34
6.10.1	Two Level Hierarchical Routing	6-18	6.18.4	How does BGP Solve the Count to Infinity Problem ?	6-34
6.11	Least Cost Algorithms	6-19	6.19	IGMP (Internet Group Management Protocol)	6-35
6.11.1	Dijkstra's Algorithm	6-19	6.19.1	Messages	6-35
6.12	Path Vector Routing	6-23	6.19.2	Operation of IGMP	6-36
6.12.1	Path Vector Messages	6-23	6.19.3	How to Join a Group ?	6-36
6.12.2	Loop Prevention	6-23	6.19.4	How to Leave a Group ?	6-36
6.12.3	Path Attributes	6-23	6.19.5	Monitoring Membership	6-37
6.13	Unicast Routing Protocols	6-24	6.19.6	Query Router	6-37
6.13.1	Routing	6-24	6.20	MPLS (Multi-Protocol Label Switching)	6-37
6.13.2	Cost or Metric	6-24	6.20.1	MPLS Header	6-37
6.13.3	Routing Tables	6-24	6.20.2	How does MPLS Work ?	6-38
6.13.4	Comparison between Static Routing and Dynamic Routing	6-24	6.20.3	Forwarding Table	6-38
6.14	Routing Protocols	6-25	6.21	Routing in MANET	6-38
6.14.1	Unicast Routing Protocols	6-25	6.21.1	Problems with Routing in Mobile Ad-hoc Networks (MANET)	6-39
6.15	RIP (Routing Information Protocol)	6-25	6.21.2	Characteristics of MANET Routing Protocol	6-39
6.15.1	RIP Updating Algorithm	6-26	6.22	Classification of Routing Protocols in Adhoc Wireless Networks	6-39
6.15.2	Initializing the Routing Table	6-26	6.22.1	Based on the Routing Information Update Mechanism	6-40
6.15.3	Updating the Routing Table	6-26	6.22.2	Based on the use of Temporal Information for Routing	6-40
6.15.4	RIP Operation	6-26	6.22.3	Based on the Routing Topology	6-40
6.15.5	RIP Message Format	6-27	6.22.4	Based on the Utilization of Specific Resources	6-40
6.15.6	Request Message	6-27	6.23	Table Driven (Proactive) Routing Protocols	6-40
6.15.7	Response Message	6-28	6.23.1	Destination Sequenced Distance Vector Routing Protocol (DSDV)	6-40
6.15.8	Timers in RIP	6-28	6.24	On-demand (Reactive) Routing Protocol	6-42
6.16	OSPF	6-28			
6.16.1	Features of OSPF	6-29			
6.16.2	Metric	6-30			
6.16.3	Types of Links	6-30			
6.16.4	Virtual Link	6-31			



6.24.1	Dynamic Source Routing Protocol (DSR)	6-42
6.24.2	Adhoc on Demand Distance Vector Routing Protocol (AODV)	6-44
•	Review Questions	6-45

Unit IV

Chapter 7 : Transport Layer **7-1 to 7-53**

Syllabus : Process to Process Delivery, Services, Socket Programming. **Elements of Transport Layer Protocols** : Addressing, Connection establishment, Connection release, Flow control and buffering, Multiplexing, Congestion Control. **Transport Layer Protocols** : TCP and UDP, SCTP, RTP, Congestion control and Quality of Service (QoS), Differentiated services, TCP and UDP for Wireless networks.

7.1	Introduction	7-2
7.2	Transport Layer Duties	7-2
7.3	Transport Layer Services	7-3
7.3.1	Process-to-Process Communication	7-3
7.3.2	Addressing : Port Number	7-3
7.3.3	Encapsulation and Decapsulation	7-5
7.3.4	Multiplexing and Demultiplexing	7-5
7.3.5	Flow Control	7-5
7.3.6	Flow Control at Transport Layer	7-6
7.3.7	Error Control	7-7
7.3.8	Combination of Flow and Error Control	7-8
7.3.9	Connectionless and Connection Oriented Services (CLTS & COTS)	7-9
7.3.10	Quality of Service (QoS)	7-11
7.4	Sockets	7-11
7.4.1	Socket Types	7-12
7.4.2	Berkeley Sockets	7-12
7.5	Elements of Transport Protocols	7-13
7.6	Connection Management	7-13
7.6.1	Connection Establishment	7-14
7.6.2	Three Way Handshake Technique	7-14
7.6.3	Connection Release	7-15
7.6.4	The Internet Transport Protocols	7-16
7.7	User Datagram Protocol (UDP)	7-16
7.7.1	Responsibilities of UDP	7-16
7.7.2	Advantages of UDP	7-17
7.7.3	User Datagram	7-17
7.7.4	UDP Pseudo Header	7-18
7.8	UDP Services	7-20
7.8.1	Process to Process Communication	7-20
7.8.2	Connectionless Services	7-20
7.8.3	Flow and Error Control	7-20
7.8.4	Checksum	7-20
7.8.5	Congestion Control	7-21
7.9	UDP Applications	7-21
7.10	Transmission Control Protocol (TCP)	7-21
7.10.1	Relationship Between TCP and IP	7-21
7.10.2	Ports and Sockets	7-22
7.11	TCP Services	7-23
7.11.1	Process to Process Communication	7-23
7.11.2	Stream Delivery Service	7-23
7.11.3	Sending and Receiving Buffers	7-23
7.11.4	Bytes and Segments	7-24
7.12	Features of TCP	7-24
7.12.1	Numbering System	7-24
7.12.2	Flow Control	7-24
7.12.3	Error Control	7-25
7.12.4	Congestion Control	7-25
7.13	The TCP Protocol	7-25
7.13.1	TCP Segment	7-25
7.13.2	The TCP Segment Header	7-25
7.13.3	Checksum	7-27
7.13.4	Encapsulation	7-27
7.14	A TCP Connection	7-28
7.14.1	TCP Connection Establishment	7-28
7.14.2	Connection Termination Protocol	7-29
7.14.3	TCP Connection Management	7-29
7.14.4	TCP Connection Release	7-30
7.15	TCP State Transition Diagram	7-30
7.16	Flow Control in TCP	7-31
7.16.1	Silly Window Syndrome	7-32
7.16.2	Nagle's Algorithm	7-32
7.17	Timers in TCP	7-33
7.18	Quality of Service (QoS)	7-33
7.18.1	Techniques for Achieving Good QoS	7-34
7.18.2	Traffic Shaping	7-34



7.18.3	Leaky Bucket Algorithm	7-35
7.18.4	Token Bucket Algorithm	7-36
7.18.5	Combination of Token Bucket and Leaky Bucket	7-37
7.18.6	Resource Reservation	7-37
7.18.7	Admission Control	7-37
7.19	TCP Congestion Control	7-37
7.19.1	Slow Start Algorithm	7-38
7.19.2	Internet Congestion Control Algorithm	7-39
7.20	Comparison of UDP and TCP	7-40
7.21	Protocols for Real Time Interactive Applications	7-41
7.21.1	RTP [Real Time Protocol]	7-41
7.21.2	RTCP [RTP Control Protocol]	7-42
7.21.3	RTCP Packets	7-43
7.22	Stream Control Transmission Protocol (SCTP)	7-44
7.22.1	UDP Performance for Internet Applications	7-44
7.22.2	TCP Performance for Internet Applications	7-44
7.22.3	Features of SCTP	7-44
7.22.4	SCTP Packets	7-44
7.22.5	SCTP Packet Format	7-45
7.22.6	General Header	7-45
7.23	Socket Programming	7-45
7.23.1	Socket Programming with TCP	7-46
7.23.2	Socket Programming with UDP	7-46
7.24	Integrated Services and Differentiated Services	7-47
7.24.1	Intserv	7-47
7.24.2	Classes of Service	7-48
7.24.3	Differentiated Services (Diffserv)	7-48
7.25	Wireless TCP and UDP	7-50
7.25.1	Solution (Indirect TCP)	7-50
7.25.2	Alternative Solution	7-50
7.25.3	Wireless UDP	7-51
7.25.4	RPC (Remote Procedure Call)	7-51
7.26	University Questions and Answers	7-53
	• Review Questions.....	7-52

Unit V**Chapter 8 : Application Layer 8-1 to 8-38**

Syllabus : Introduction, Web and HTTP, Web Caching, DNS, **Email** : SMTP, MIME, POP3, Webmail, FTP, TELNET, DHCP, SNMP.

8.1	Application Layer	8-2
8.1.1	Position of Application Layer	8-2
8.2	Domain Name System (DNS)	8-2
8.2.1	How does DNS Work ?	8-3
8.2.2	Name Space	8-3
8.2.3	Flat Name Space	8-3
8.2.4	Hierarchical Name Space	8-3
8.3	Domain Name Space	8-3
8.4	Distribution of Name Space	8-5
8.4.1	Hierarchy of Name Servers	8-5
8.5	DNS in the Internet	8-6
8.5.1	Generic Domains	8-6
8.5.2	Country Domain	8-6
8.5.3	Inverse Domain	8-6
8.6	Name Address Resolution	8-6
8.6.1	Recursive Resolution	8-7
8.6.2	Iterative Resolution	8-7
8.6.3	The DNS Message Format	8-7
8.6.4	Caching	8-8
8.6.5	DNS Records	8-8
8.7	World Wide Web (WWW)	8-9
8.7.1	Web from the Users Side	8-9
8.7.2	Web from the Servers Side	8-11
8.7.3	WWW Architecture	8-11
8.7.4	Browser (Web Client)	8-11
8.7.5	Server	8-11
8.7.6	Uniform Resource Locator (URL)	8-11
8.8	Web Documents	8-12
8.8.1	Static Documents	8-12
8.8.2	HTML (Hypertext Markup Language)	8-12
8.8.3	Dynamic Document	8-12
8.8.4	Active Documents	8-13
8.9	HTTP (Hypertext Transfer Protocol)	8-13
8.9.1	HTTP Operation	8-13
8.9.2	The Web and HTTP	8-14



8.9.3	Types of HTTP Connections	8-14	8.18.3	Advantages of DHCP	8-32
8.9.4	HTTP Messages	8-16	8.18.4	Components of DHCP	8-33
8.9.5	Request Message	8-16	8.18.5	DHCP Operation	8-33
8.9.6	Methods (Request Type)	8-16	8.18.6	DHCP Architecture	8-34
8.9.7	Response Message	8-17	8.18.7	The DHCP Client	8-34
8.9.8	Headers	8-17	8.18.8	DHCP Server	8-34
8.9.9	Comparison of HTTP and SMTP	8-18	8.19	Simple Network Management Protocol (SNMP) ..	8-35
8.10	Proxy Server	8-18	8.19.1	Managers and Agents	8-35
8.10.1	HTTP Security	8-19	8.19.2	Management Components	8-35
8.11	Electronic Mail	8-19	8.19.3	Structure of Management Information (SMI)	8-36
8.11.1	E-mail Architecture and Services	8-19	8.19.4	Management Information Base (MIB)	8-37
8.11.2	Message Formats	8-20	8.19.5	Simple Network Management Protocol (SNMP)	8-37
8.12	MIME – Multipurpose Internet Mail Extensions ..	8-21	8.20	University Questions and Answers	8-38
8.12.1	Principle of MIME	8-21	• Review Questions	8-38	
8.13	Message Transfer Agent SMTP	8-23	Unit VI		
8.13.1	Commands and Responses	8-23	<hr/>		
8.13.2	SMTP (Simple Mail Transfer Protocol)	8-23	Chapter 9 : Security 9-1 to 9-35		
8.13.3	Components of E-mail System	8-24	Syllabus : Introduction, Security services, Need for security, Key principles of security, Threats and vulnerability, Types of attacks, ITU-T X-800 Security architecture for OSI, Security policy and mechanisms, Operational model of network security, Symmetric and asymmetric key cryptography. Security in network, Transport and Application, Introduction to IPsec, SSL, HTTPS, S/MIME, Overview of IDS and Firewalls.		
8.13.4	SMTP Commands	8-25	9.1	Introduction	9-2
8.13.5	SMTP Operation	8-25	9.2	Security Services	9-2
8.13.6	Comparison of HTTP and SMTP	8-25	9.3	Need for Security	9-2
8.14	Message Access Agent POP and IMAP	8-25	9.4	Key Principles of Security	9-3
8.14.1	POP 3	8-26	9.4.1	Security Goals	9-3
8.14.2	IMAP4	8-26	9.4.2	Threat	9-3
8.14.3	Comparison of IMAP and POP 3	8-27	9.5	Security Attacks	9-3
8.15	Web Based Mail	8-27	9.5.1	Attacks on Confidentiality	9-4
8.16	File Transfer Protocol (FTP)	8-27	9.5.2	Attacks on Integrity	9-4
8.16.1	Communication in FTP.....	8-28	9.5.3	Attacks on Availability	9-4
8.16.2	File Types	8-29	9.6	ITU-T X-800 Security Architecture for OSI	9-4
8.16.3	Data Structure	8-29	9.7	Security Policy and Mechanisms	9-5
8.16.4	Transmission Mode	8-29	9.7.1	Specific Security Mechanisms	9-5
8.16.5	File Transfer	8-29	9.7.2	Pervasive Security Mechanisms	9-6
8.16.6	FTP Commands	8-29	9.8	Model of Network Security	9-6
8.16.7	Anonymous FTP	8-30	9.9	Techniques to Achieve Security Goals	9-7
8.17	Remote Login : TELNET	8-30			
8.17.1	TELNET	8-30			
8.17.2	Network Virtual Terminal (NVT)	8-31			
8.17.3	Security Problems of TELNET	8-31			
8.18	Host Configuration DHCP	8-31			
8.18.1	Previously used Protocols	8-32			
8.18.2	DHCP	8-32			



9.9.1	Cryptography	9-7	9.18.4	Security Protocols of IPsec	9-20
9.9.2	Steganography	9-8	9.18.4.1	Authentication Header (AH)	9-20
9.10	Cryptographic Attacks	9-8	9.18.4.2	Encapsulating Security Payload (ESP)	9-21
9.10.1	Passive Attacks	9-8	9.18.5	Services Provided by IPsec	9-21
9.10.2	Active Attacks	9-9	9.18.6	Security Association	9-22
9.10.3	Comparison of Active and Passive Attacks	9-10	9.18.7	Internet Key Exchange (IKE)	9-22
9.11	Cryptography Techniques	9-10	9.19	Transport Layer Security	9-22
9.12	Symmetric Key Cryptography	9-10	9.19.1	Design Goals of SSL	9-23
9.12.1	Advantages of Symmetric Key Ciphers	9-11	9.19.2	SSL - Secure Socket Layer	9-23
9.12.2	Disadvantages of Symmetric Key Ciphers	9-11	9.19.3	SSL Architecture	9-23
9.12.3	Types of Symmetric Key Ciphers	9-11	9.19.4	Services	9-23
9.12.4	Traditional Symmetric Key Ciphers	9-11	9.19.5	Key Exchange Algorithms	9-24
9.12.5	A Modern Block Cipher	9-11	9.19.6	Encryption/Decryption Algorithms	9-24
9.13	Data Encryption Standard (DES)	9-11	9.19.7	Hash Function (Algorithm)	9-24
9.13.1	Key Generation	9-12	9.19.8	Cipher Suite	9-24
9.14	Asymmetric Key Cryptography	9-12	9.19.9	Compression Algorithm	9-24
9.14.1	Public (Asymmetric) Key Cryptosystem ..	9-13	9.19.10	Cryptographic Parameter Generation	9-24
9.14.2	Advantages	9-13	9.19.11	Sessions and Connections	9-24
9.14.3	Disadvantages	9-13	9.19.12	Four Protocols in SSL	9-24
9.14.4	The RSA Cryptosystem	9-14	9.20	Application Layer Security	9-25
9.14.5	Comparison of Symmetric Key and Asymmetric Key Cryptosystems	9-14	9.20.1	Email Security	9-25
9.15	Security Services	9-15	9.20.2	PGP - Pretty Good Privacy	9-25
9.15.1	Message Integrity	9-15	9.20.3	PGP Scenarios	9-26
9.15.2	Message Authentication	9-16	9.20.4	PGP Working	9-27
9.16	Digital Signature	9-16	9.20.5	S/MIME (Secure/Multipurpose Internet Mail Extension)	9-28
9.16.1	Digital Signature Process	9-16	9.21	Firewalls	9-30
9.16.2	Signing the Digest	9-17	9.21.1	Types of Firewalls.....	9-30
9.16.3	Services Provided by Digital Signature ..	9-17	9.21.2	Packet Filter Firewall	9-30
9.16.4	Entity Authentication	9-18	9.21.3	Proxy Based Firewall	9-30
9.17	Introduction to Internet Security	9-18	9.21.4	Virtual Private Networking (VPN)	9-31
9.18	Network Layer Security	9-18	9.22	VPN Firewall	9-31
9.18.1	IPsec (IP security)	9-19	9.22.1	Working of VPN Firewall	9-31
9.18.2	Modes of Operation of IPsec	9-19	9.23	Intrusion Detection Systems (IDS)	9-32
9.18.3	Comparison between Transport and Tunnel Mode	9-20	9.23.1	Classification of IDS	9-33
			9.23.2	Limitations of IDS.....	9-33
				• Review Questions	9-33

