

7.1 COMPUTER NETWORKS

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7.1.1 OBJECTIVE AND RELEVANCE

A computer network is a network of computers interconnected by one or more transmission paths. Computer networks are complex systems that almost magically link millions of computers and more than a billion telephones across the globe. Computer networks, especially the world wide Internet, has become a daily reality for millions of people. The computers are said to be interconnected if they are able to exchange information. This data exchange provides for many computer based services which we often take for granted in our daily lives, such as bank teller machines, point-of-sale terminals, check-verification devices and even the guidance of the space shuttle.

7.1.2 SCOPE

Studying computer networks, students will be able to understand the need for the protocols and IEEE standards about the OSI models and its layers. They can understand the improvement in interconnectivity and communications. The subject also provides a platform for exchange of information across heterogeneous networks and standardizes various products and services among the otherwise proprietary manufacturers. The subject provides information about Internet concepts. In the present complex business environment there is need for formal training of an engineer in the discipline of computer networks. This course fulfills these requirements.

7.1.3 PREREQUISITES

Basic Knowledge on Digital Communications is essential and Programming Knowledge is desirable.

7.1.4 JNTU SYLLABUS

UNIT-I OBJECTIVE

Upon completion of this unit, the student would be able to understand the Basic concept of Network Models and identify categories of networks based on requirements and also to classify networks into different types.

SYLLABUS

Introduction to networks, Internet, Protocols and standards, the OSI model, layers in OSI model, TCP/IP suite, addressing, Analog and digital signals.

UNIT-II OBJECTIVE

The unit covers in detail about physical layer in which student may be able to understand various operations of physical media along with applying different protocols for implementation.

SYLLABUS

Physical layer: digital transmission, multiplexing, transmission media, circuit switched networks, datagram networks, virtual circuit networks, switch and telephone network

UNIT-III OBJECTIVE

This unit covers one of the important layer used to carry the information in the form of frames called data link layer. This layered approach used to design various protocols and apply them to the knowledge of elementary data link layers.

SYLLABUS

Data link layer: Introduction, Block coding, cyclic codes, checksum framing, flow and error control, Noiseless channels, noisy channels, HDLC, point to point protocols.

UNIT-IV

OBJECTIVE

This unit covers in details the two sub layers of the data link layer. It deals with broadcast networks and their protocols. At the end of this unit students would be able to identify various popular LAN protocols as well as satellite and some other broadcast networks.

SYLLABUS

Medium Access sub layer: Random access, controlled access, channelization, IEEE standards, Ethernet, Fast Ethernet, Giga-Bit Ethernet, Wireless LANs.

UNIT-V

OBJECTIVE

The students will become familiar with connecting computers in LAN as well as wider connectivity of computers through Satellite WAN and linking the computers using optical fiber SONET.

SYLLABUS

Connecting LANs, backbone networks and virtual LANs, wireless WANs, SONET, frame relay and ATM..

UNIT-VI

OBJECTIVE

This unit covers about network layer: It explains both dynamic routing and general principles for preventing congestion and also give the brief idea about internetworking. At the end of this unit the student will be able to identify various protocols applied in routing algorithms in order to make efficient operations.

SYLLABUS

Network layer: Logical addressing, internetworking, tunneling address mapping, ICMP, IGMP, forwarding, uni-cast routing protocols, multicast routing protocols.

UNIT-VII

OBJECTIVE

This unit deals with the Transport layer: It gives details about transport protocols and at the end of this unit, the student would be in a position to identify the significance of TCP model and prevention steps to overcome the congestion problem as well as to improve the Quality of Service.

SYLLABUS

Transport Layer: Process to process deliver, UDP and TCP protocols, SCTP, data traffic, congestion, congestion control, QoS, integrated services, differentiated services, QoS in switched networks

UNIT-VIII

OBJECTIVE

This unit deals with the application layer and its relevant protocols. The student will be able to identify various services at application layer. Further the student will be familiar with various user friendly features of popular applications like email and FTP.

SYLLABUS

Application layer - Domain name space, DNS in internet, electronic mail, FTP, WWW, HTTP, SNMP, multi-media, network security .

7.1.4.2 GATE SYLLABUS

Not Applicable.

7.1.4.3 IES SYLLABUS

Not Applicable.

7.1.5 SUGGESTED BOOKS

TEXT BOOKS

- T1 Data Communications and Networking - Behrouz A. Forouzan. Fourth Edition TMH, 2006
- T2 Computer Networks - Andrew S Tanenbaum, 4th Edition. Pearson Education.

REFERENCE BOOKS

- R1 An Engineering Approach to Computer Networks-S.Keshav, 2nd Edition, Pearson Education.
- R2 Understanding Communications and Networks, 3rd Edition, W.A. Shay, Cengage Learning.
- R3 Computer and Communication Networks, Nader F. Mir, Pearson Education.
- R4. Computer Networking: A Top-Down Approach Featuring the Internet, James F.Kurose, K.W. Ross, 3rd Edition, Pearson Education.
- R5. Data and Computer Communications, G.S. Hura and M.Singhal, CRC Press, Taylor and Fransis Group
- R6. Data Communications and Computer Networks, P.C. Gupta, PHI.

7.1.8 JOURNALS

INTERNATIONAL

- 1. IEEE Transactions on Communication Technology.
- 2. IEEE/ACM Transactions on Networking.
- 3. IEEE Communication Magazine.
- 4. IEEE Transactions on wireless communications.

NATIONAL

- 1. Journal of communication Engineering system, STM
- 2. Journal of computer technology and Applications, STM
- 3. Inventi impact Computer Networks and Communications

7.1.9 FINDINGS AND DEVELOPMENTS

- 1 Dynamic Packet Length Control in Wireless Sensor Networks, Wei Dong, chun chen, Jiajun & Xianghua, IEEE Transactions on Wireless communications, Vol. 13, No. 03, Page No. 1172, Mar 2014
- 2 Packet Loss Control using Tokens at the network edge, K.K.Nikil, G.Sunil Santhosh Kumar, International journal of Computer Applications in Engineering, Technology and Science Vol. 06, issue 01, Page No. 74-79, Oct 2013-Mar 2014.
- 3 Security Enhancement of Alarm Protocol in Mobile Adhoc Networks, Piyush Singh, Sandeep Kaur, Inventi impact Computer Networks and Communications, Vol. 13, issue 2, Page No. 70, Apr-jun 2013
4. A frame work for Routing Assisted Traffic Monitoring, S. Raza, a, Huang., C.N. Chuah, S. Seetharaman and J.P. Singh, IEEE/ACM Transactions on Networking, Vol. 20, No. 1, Page 45-56, February 2012.
5. Network, Coding Multicast Networks with QoS Guarantees, Y. Xuan and C.T. Lea, IEEE/ACM Transactions on Networking, Vol. 19, No. 1, page, 265-274, February, 2011.
6. A Practical Adaptive Pacing Scheme for TCP in Multihop Wireless Networks, S.M., Elrakabawy and C.Lindeman. IEEE/ACM Transactions on Networking, Vol. 19, No. 4, page 975-988, August, 2011.

7.1.10. SESSION PLAN

Sl. No.	Topics in JNTU Syllabus	Modules and Sub Modules	Lecture No.	Suggested Books	Remarks
UNIT – I					
1	Introduction to networks	objective and relevance, scope of the subject, pre-requisites, suggested books	L1		
2	Internet	Network models, Internet today	L2	T1-Ch1, T2-Ch1	
3	Protocols and standards	Standard organizations, Internet standards	L3	T1-Ch1, T2-Ch1	
4	The OSI model	Layered architecture	L4	T1-Ch2, T2-Ch1, R1-Ch5	
5	Layers in OSI model	Different layers	L5	T1-Ch2, T2-Ch1, R1-Ch5	
6	TCP/IP suite	Physical, network, transport, application layers	L6	T1-Ch2, T2-Ch1	
7	Addressing	Physical, logical, port, Specific Addresses	L7	T1-Ch2, T2-Ch1	
8	Analog and digital signals	Analog and digital signals	L8	T1-Ch3	
UNIT-II					
9	Physical layer: Digital transmission	Line coding and block coding	L9	T1-Ch4	
10	Multiplexing	Frequency, wave length, synchronous TDM	L10	T1-Ch6, T2-Ch2, R1-Ch7	
11	Transmission media	Guided and Unguided	L11	T1-Ch7, T2-Ch2	
12	Circuit switched networks	Three phases, efficiency, delay	L12	T1-Ch8, , T2-Ch2	
13	Datagram networks	Routing table, efficiency, delay	L13	T1-Ch8	
14	Virtual circuit networks	Three phases, efficiency, delay	L14	T1-Ch8	
15	Switch and telephone network	Components, LATAs signaling, Service provided by Telephone Networks	L15	T1-Ch8,9, T2-Ch2, R1-Ch8	
UNIT-III					
16	Data link layer: Introduction	Types of error, Redundancy, Coding	L16	T1-Ch10,T2-Ch3	
17	Block coding	Detection and correction Hamming distance	L17	T1-Ch10,T2-Ch3	
18	Cyclic codes	CRC, Polynomials, Advantage of cyclic codes	L18	T1-Ch10,T2-Ch3	
19	Checksum framing	Idea, Internet checksum, fixed sized, variable size framing	L19	T1-Ch10, 11, T2-Ch3	
20	Flow and error control,	Flow control and error control	L20	T1-Ch11, T2-Ch3 R1-Ch13	
21	Noiseless channels	Simplest protocol, Stop and wait protocol	L21	T1-Ch11, T2-Ch3 R4-Ch5	

Sl. No.	Topics in JNTU Syllabus	Modules and Sub Modules	Lecture No.	Suggested Books	Remarks
22	Noisy channels	Stop & Wait ARR, Go-back-N ARR, Selective repeat ARR	L22	T1-Ch11, T2-Ch3	
23	HDLC	Configuration, Frames controlled field	L23	T1-Ch11, T2-Ch3	
24	Point to point protocols	Framing multiplexing, Multi link PPP	L24	T1-Ch11	
UNIT-IV					
25	Medium Access sub layer Random access	ALOHA, CSMA/CD, CSMA/CA	L25	T1-Ch12, T2-Ch4 R1-Ch7	
26	Controlled access	Reservation, polling, token passing	L26	T1-Ch12	
27	Channelization	FDMA, TDMA, CDMA	L27	T1-Ch12	
28	IEEE standards	Data link layer, Physical layer	28	T1-Ch13, T2-Ch4, R4-Ch5	
29	Ethernet	MAC sub layer Physical layer	29	T1-Ch13, T2-Ch4	
30	Fast Ethernet	MAC sub layer Physical layer	30	T1-Ch13, T2-Ch4	
31	Giga-Bit Ethernet	MAC sub layer Physical layer Ten – Gigabit Ethernet	31	T1-Ch13, T2-Ch4	
32	Wireless LANs	IEEE 802.11, Blue tooth	32	T1-Ch14, T2-Ch4	
UNIT-V					
33	Connecting LANs	Connecting devices	L33	T1-Ch15, T2-Ch4	
34	Backbone networks and	Bus, star, connecting remote LANS	L34	T1-Ch15, T2-Ch5	
	virtual LANs	Membership configuration, IEEE standard, advantages	L35	T1-Ch15, T2-Ch5	
35	Wireless WANs,	Cellular Telephony Satellite networks	L36	T1-Ch16	
36	SONET	Architecture, Layers Frames, Multiplexing	L37-38	T1-Ch17, T2-Ch2 R1-Ch15	
37	Frame relay and ATM	Architecture, Layers, Address, Congestion control and QOS	L39	T1-Ch18, T2-Ch1	
UNIT-VI					
38	Network layer: Logical addressing	IPV4 addresses, IPV6 address	L40	T1-Ch19, T2-Ch5 R1-Ch10	
39	Internetworking	Data gram network, connection less network	L41	T1-Ch20, T2-Ch5, R1-Ch10	
40	Tunneling address mapping	Tunneling, Addressing Mapping ARP, RARP, BOOPP & DHCP	L42	T1-Ch21, T2-Ch2	

Sl. No.	Topics in JNTU Syllabus	Modules and Sub Modules	Lecture No.	Suggested Books	Remarks
41	ICMP	Types of Messages, message Format, Reporting Query, Debugging tools	L43	T1-Ch21, T2-Ch5 R1-Ch15	
42	IGMP	Management, format, operation, Encapsulation	L44	T1-Ch21, T2-Ch5	
43	Forwarding	Techniques, process, tables	L45	T1-Ch22, T2-Ch5	
44	Uni-cast routing protocols	Routings	L46	T1-Ch22, T2-Ch5 R4-Ch4, R1-Ch11	
45	Multicast routing protocols	Routings and Protocols	L47	T1-Ch22, T2-Ch5 R4-Ch4, R1-Ch11	
UNIT VII					
46	Transport Layer: Process to process deliver	Client server, Multiplexing Connection less, three protocols	L48	T1-Ch23	
47	UDP and TCP protocols	Datagram, Checksum, Operation use	L49	T1-Ch23, T2-Ch6 R4-Ch3, R1-Ch15	
48	SCTP, data traffic	Service, features, format, control, Data Traffic	L50	T1-Ch23	
49	Congestion, Congestion control	Open loop and closed loop,	L51	T1-Ch24, T2-Ch5 R4-Ch3	
50	QoS, integrated services	Flow characteristics and classes	L52	T1-Ch24, T2-Ch5 R4-Ch6	
51	Differentiated services	DS field	L53	T1-Ch24, T2-Ch5 R4-Ch6	
52	QoS in switched networks	Frame relay, ATM	L54	T1-Ch24, T2-Ch5 R4-Ch6	
UNIT-VIII					
53	Application layer – Domain name space	Label, Domain name	L55	T1-Ch25, T2-Ch7, R4-Ch2	
54	DNS in internet	Generic, country, inverse domain	L56	T1-Ch25, T2-Ch7, R4-Ch2	
55	electronic mail	Architecture, Agent, Web based mail	L57	T1-Ch26, T2-Ch7, R4-Ch2	
56	FTP, WWW, HTTP	Anonymous FTP Architecture, Web documents, HTTP transactions, Proxy server	L58	T1-Ch26,27, T2-Ch5, R4-Ch2 R4-Ch15	
57	SNMP, multi-media	SNMP: Concept, Components, MIB, SNMP, UDP ports, Multimedia: Digitizing audio and video, compression	L59	T1-Ch28,29 T2-Ch7, R4-Ch6	
57	Network security	Securities services	L60	T1-Ch3, T2-Ch8 R4-Ch7	

7.1.11 TUTORIAL PLAN

Sl. No.	Title	Salient topics to be discussed
1	OSI Model	Functionality of each layer with Interface diagrams
2	Analog and Digital Signals	Problems Related to Analog and Digital Signals
3	Transmission Media	Coaxial, twisted pair and Optical fiber cables
4	Switching Networks	Concepts with comparisons and similarities
5	Framing Techniques	Character count, bit and byte stuffing
6	Cyclic Redundancy Check	Problems related to CRC and Check Sum
7	Channel Access	Multiple accessing and controlling methods
8	Wireless LAN	802.11 protocol stack ,physical layer and MAC sub layer
9	SONET and ATM	Devices , Layers and Frame Formats
10	Routing Algorithms	Distance vector routing and link state routing related examples
11	Logical Addressing	Classful and Classless Addressing related problems
12	Multicast Routing Protocols	Compare multicast and broad cast routing with its applications
13	Congestion control	Principles, prevention policies and congestion control in VC and datagram subnets
14	SCTP	Services, Frame formats and Features
15	Domain name system	Name space, Resource records and name servers
16	World wide web	Architectural overview, static and dynamic web documents

7.1.12 STUDENT SEMINAR TOPICS

1. "Wireless Local Area Networks". Douligeris, Dimitrios IV., IEEE computer networks, Nov 2005.
2. "4G Network Technologies for Mobile Telecommunications" - Ahmed M. Safwat, Hussen T. Mouftah, IEEE computer networks, Nov 2005.
3. "Fault Tolerant Detection in Wireless Sensor Networks", IEEE transaction on computers, Vol.54, issues 2, Nov 2005.

4. "Security in the internet: FIRE WALLS", Data Communications and Networking - Behrouz A. Forouzan. Fourth Edition TMH, 2006
5. "Voice over internet" Data Communications and Networking - Behrouz A. Forouzan. Fourth Edition TMH, 2006

7.1.13 QUSESTION BANK

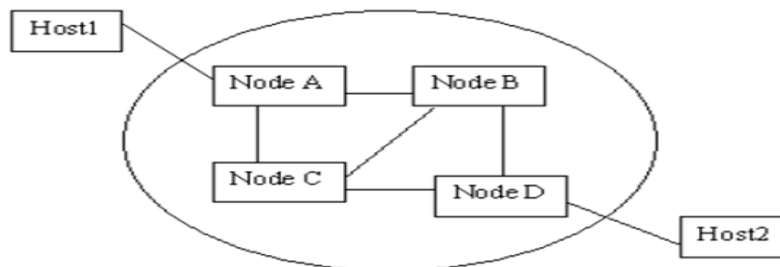
UNIT – I

1. i. Draw and discuss the Seven layer ISO-OSI architecture.
 ii. Write about the TCP/IP Model with neat diagram (Nov 13)

2. i. Write any four reasons for using layered protocols.
 ii List down the advantages and disadvantages of OSI reference model. Compare them with the TCP/IP model. (Nov 13)

3. i. Explain the function of various layers of OSI model.
 ii. Explain the terms:
 - a) Interface
 - b) Protocol
 - c) Standard. (Dec12)

4. i. With a neat diagram explain the relation between layers at an interface.
 ii. Define OSI reference model. Suppose in an arbitrary network as shown in Figure 7b the Host1 communicates with Host2. During the process of communication which layers as per OSI reference model will remain transparent to the nodes A to D and why? (Nov 11)



5. Explain with an example how data can be transmitted using the OSI model. (Nov 11)

6. i. What are the advantages of having layered architecture? Mention the layers of ISO-OSI reference model.
 ii. What is Internet? Mention some of the applications of Internet? (Nov 11,08)

7. i. Distinguish among LAN, MAN, WAN and Internet.
 ii. What are the two protocols that are defined at the transport layer of the TCP/IP reference model? Mention their applications? (Nov 10)

8.
 - i. Discuss the basic functions performed by different layers of ISO-OSI reference model.
 - ii. List two advantages and disadvantages of having international standards for network protocols.

(Nov 09,07, 06, May 06)
9.
 - i. How does Internet differs from WAN?
 - ii. Give an example where we require.
 - a. Simplex communication
 - b. Half duplex communication
 - c. Full duplex communication
 - iii. What are the two reasons for using layered protocols.

(Nov 09)
10.
 - i. Discuss about the architecture of DQDB Metropolitan Area Network?
 - ii. What is the advantages of an open system environment? Discuss the different functions performed by various layers of OSI model.

(Nov 09)
11.
 - i. What are the various applications of Computer Networks?
 - ii. What are the advantages of multipoint connection over a point-to-point connection? What are some of the factors that determine whether a communication system is a LAN, MAN or WAN?

(Nov 09,08)
12.
 - i. Briefly discuss about the ways network can differ.
 - ii. Briefly discuss about addressing used at various layers for computers.

(Nov 09)
13.
 - i. Write any four reasons for using layered protocols.
 - ii. List two ways in which the OSI reference model and the TCP/IP reference model are the same and list in which they differ.
 - iii. What is the principle difference between CO communication and CL communication.

(Nov09, Feb08, Nov07, Apr06)
14.
 - i. Compare point -to-point channels with broadcast channels along with suitable examples?
 - ii. A collection of five routers is to be collected in a point-to-point subnet. Between each pair of routers, the designers may put a high speed line, a medium-speed line, a low-speed line, or no line. If it takes 100ms of computer time to generate and inspect each topology, how long will it take to inspect all of them to find the one that best matches the expected load?

(Nov 08)
15.
 - i. Define the following terms:
 - a. Computer Network
 - b. Peer process
 - c. Protocol
 - d. Interface.

16. i. Explain problems of the TCP/IP model and protocols?
 ii. With a neat diagram explain ARPANET design? **(Nov 08)**
17. i. Briefly explain about the TCP/IP reference model.
 ii. Compare and contrast OSI and TCP/IP models. **(Feb 08, Apr 06)**

UNIT – II

1. i. Write about the twisted pair cable and its applications.
 ii. Compare Narrow band and broad band ISDN. **(Nov/Dec 13)**
2. i. Write the advantages of optical fiber over twisted-pair and coaxial cables.
 ii Differentiate between data gram packet switching and virtual circuit switching.**(Nov 13)**
- 3.i. Discuss the error detection and correction in detail. Distinguish between Synchronous and Statistical Time Division Multiplexing
 ii.Give the characteristics of various transmission media and compare them. **(Dec 12)**
- 4 i. Discuss circuit switching and packet switching methods. Also discuss their merits and demerits.
 ii. Differentiate between the following:
 i. bit rate and baud rate
 ii. single mode fiber and multi mode fiber. **(Nov 11)**
5. Differentiate between optical fiber and coax. **(Nov 11)**
6. i. Compare Circuit switching with Packet switching.
 ii. Consider any two networks of your choice which support Circuit switching or Packet switching and explain them in detail.
 iii. Explain the strategy that can be used at the receiver to achieve reordering of the packets. **(Nov 11)**
7. i. What are the different media used in data communication systems? Compare their merits and demerits.
 ii. Assume a data stream is made of ten 0's. Encode the stream, using Manchester and differential Manchester coding schemes. How many Changes (vertical line) can you find for each scheme?
8. i. Differentiate between the following:
 a. Category 3 twisted pairs & Category 5 twisted pairs
 b. Broad band networking using dual cable & single cable
 c. Single mode fiber and multi mode fiber
 ii. Which is more efficient, circuit switching or packet switching? Why? In a two byte address field, what is the maximum number of permanent virtual circuits possible? What about a three byte address?
(Nov 10)
9. i. What is the difference between a passive star and an active repeater in a fiber optic network?
 ii. Discuss the features of integrated service digital network? **(Nov 09)**
10. i. Explain about ISDN architecture?
 ii. Differentiate between optical fiber and coax? **(Nov 09)**

11. i. Discuss in detail about asynchronous communication?
ii. Explain three transmission media of physical layer. **(Nov 09, 08)**
12. What is the difference between connection-oriented and connectionless switching. **(Nov 09, Aug 06, Apr 05)**
13. i. Explain three transmission media of physical layer.
ii. Discuss in detail about Time division switches? **(Nov 09, Apr 05)**

UNIT – III

1. i. Discuss the error detection and correction in data link layer.
ii. Write about the stop and wait protocol. **(Nov/Dec 13)**
2. i. List and explain the services provided by data link layer.
ii. A bit string, 011110111110111110, needs to be transmitted at the data link layer.
What is the string actually transmitted after bit stuffing? **(Nov 13)**
- 3.i. Write about encoding and decoding procedure used in cyclic codes and checksum with examples.
ii. Give the frame format of HDLC. **(Dec 12)**
4. i. How will you determine the performance of stop and wait protocol?
ii. What is piggybacking? What are its advantages?
iii. A upper layer message is split into 10 frames, each of which has a 80 percent chance of arriving undamaged. If no error control is done by the data link protocol, how many times must the message be sent on the average to get the entire thing through? **(Nov 11)**
5. Imagine that you are writing the data link software for a line used to send data to you, but not from you. The other end uses HDLC, with a 3-bit sequence number and a window size of seven frames. You would like to buffer as many out of sequence frames as possible to enhance efficiency, but you are not allowed to modify the software on the sending side. Is it possible to have a receiver window greater than one, and still guarantee that the protocol will never fail? If so, what is the largest window that can be safely used? **(Nov 11)**
6. i. Discuss about character stuffing and bit stuffing framing techniques with examples. Mention their advantages and disadvantages.
ii. Discuss about the simple protocol for a noisy channel. **(Nov 11)**

7. i. Why is the need for error control at the data link layer? **(Nov 11)**
ii. Discuss about PPP.
8. i. Mention and discuss the functioning of data link layer protocols in detail.
ii. Data link protocols almost always put the CRC in a trailer, rather than in the header. Why? **(Nov 10)**
9. i. What is the check summed frame transmitted if the message is 1101011011 and the generator polynomial is x^4+x+1 using CRC.
ii. Give the detailed description is HDLC frame format? **(Nov 10)**
10. i. A block of bits with n rows and k columns uses horizontal and vertical parity bits for error detection. Suppose that exactly 4 bits are invented due to transmission errors. Derive an expression for the probability that the error will be undetected.
ii. Explain about the three kinds of frames in HDLC protocol. **(Nov 10)**
11. i. Discuss the error control technique which is commonly used in data network. What value for N is used in Go-back-N ARQ technique used in ARPANET and why?
ii. Imagine that you are writing the data link software for a line used to send data to you, but not from you. The other end uses HDLC, with a 3-bit sequence number and a window size of seven frames. You would like to buffer as many a out of sequence frames as possible to enhance efficiency, but you are not allowed to modify the software on the sending side. Is it possible to have a receiver window greater than one, and still guarantee that the protocol will never fail? If so, what is the largest window that can be safely used?
(Nov 10, 09)
12. i. Draw the phase diagram for bringing a line up and down using PPP?
ii. Discuss about a simplex stop-and-wait protocol? What are its merits and demerits? **(Nov 09)**
13. i. Draw, and explain point-to-point protocol.
ii. What is SLIP? What are the disadvantages of it. **(Nov 09)**
14. i. Describe the different types of LCP packets?
ii. A 3000km long T1 trunk is used to transmit 64byte frames using sliding window protocol using go-back N. If the propagation speed is 6sec/km, how many bits should the sequence numbers be?
(Nov 09)
15. i. What is SLIP? What are the disadvantages of it?
ii. With an example, explain the importance of sequence numbers for Acknowledgements.**(Nov 09, 07)**
16. i. Draw and explain about HDLC protocol.

- ii. Draw and explain point-to-point protocol. **(Nov 09, Feb 07)**
17. i. Imagine a sliding window protocol using so many bits for sequence numbers that wrap around never occurs. What relations must hold among the four window edges and the window size.
- ii. PPP is based closely on HDLC, which uses bit stuffing to prevent accidental flag . **(Nov 09, Apr 06)**
18. i. Explain the operation of SLIP.
- ii. Write different types of LCP packets that are defined in RFC 1661. **(Nov 09.04)**
19. i. Discuss the use of a hamming code to correct burst errors?
- ii. Explain sliding window protocol using go-back-n? What are its advantages? and disadvantages? **(Nov 08)**
20. i. Explain one bit sliding window protocol. Give the advantages and disadvantages of one-bit sliding window protocol?
- ii. Discuss the services provided by the data link layer to the network layer? **(Nov 08)**
21. Explain in detail the two data link protocols widely used in the Internet? **(Nov 08)**
22. i. Mentioning the advantages and disadvantages, explain sliding window protocol using Go back n and using selective repeat.
- ii. Draw, and explain about HDLC protocol. **(Feb 08, May 06)**
23. i. What is the remainder obtained by dividing $x^7 + x^5 + 1$ by the generator $x^3 + 1$?
- ii. If the bit string 011110111110111110 is bit stuffed. What is the output of the string? **(Feb 08, Nov 07)**

UNIT IV

1. i. write about the MAC addresses with examples.
- ii. write short notes on wireless LANS. **(Nov/Dec 13)**
2. i. List and explain the key assumptions of dynamic channel allocation methods.
- ii. Discuss in brief MAC frame structure for IEEE 802.3? **(Nov 13)**
3. Explain and compare various controlled access and channelization protocols used in MAC sub layer. **(Dec 12)**

4.
 - i. Explain the protocol designed for wireless LANs.
 - ii. Imagine two LAN bridges, both connecting pair of 802.4 networks. The first bridge is faced with 1000 512-byte frames per second that must be forwarded. The second is faced with 200 4096-byte frames per second. Which bridge do you think will need the faster CPU. Discuss. **(Nov 11)**
5.
 - i. Explain in detail binary count down collision free protocol.
 - ii. Give the detailed description of 802.3 frame format. **(Nov 11)**
6.
 - i. Discuss about fast Ethernet cabling.
 - ii. Explain various token bus control frames. **(Nov 11)**
7.
 - i. Explain the protocol designed for wireless LANs.
 - ii. Imagine two LAN bridges, both connecting pair of 802.4 networks. The first bridge is faced with 1000 512-byte frames per second that must be forwarded. The second is faced with 200 4096-byte frames per second. Which bridge do you think will need the faster CPU? Discuss. **(Nov 10)**
8.
 - i. Which IEEE 802 specification is similar to the Ethernet standard? How CSMA/CD protocol is different than that of Ethernet protocol? How does CSMA/CD resolve the problem of line contention?
 - ii. A group of N stations share a 56-kbps pure ALOHA channel. Each station outputs a 1000-bit frame on an average of once every 100 sec, even if the previous one has not yet been sent. What is the maximum value of N? **(Nov 10)**
9.
 - i. Consider the delay of pure ALOHA versus slotted ALOHA at low load. Which one is less? Explain your answers.
 - ii. Consider building a CSMA/CD network in at 1 Gbps over a 1-km cable with no repeaters. The signal in the cable is 200,000 km/sec. What is the minimum frame size? **(Nov 09, Aug 06)**
10. Write short notes on:
 - i. Ethernet
 - ii. Wireless LAN
 - iii. Source routing bridge
 - iv. Remote bridges **(Nov 09)**
11.
 - i. What is pure ALOHA and slotted ALOHA? Mention the advantages of slotted ALOHA?
 - ii. A seven - story office building has 15 adjacent offices per floor. Each office contains a wall socket for a terminal in the front wall, so the sockets form a rectangular grid in the vertical plane, with a separation of 4m between sockets, both horizontally and vertically. Assuming that it is feasible to run a straight cable between any pair of sockets, horizontally, vertically, or

- diagonally, how many meters of cable are needed to connect all sockets using.
- a. a star configuration with a single router in middle?
 - b. an 802.3 LAN?
 - c. a ring network (with out a wire center)? **(Nov 09)**
12. i. A 4-Mbps token ring has a token-holding timer value of 10m sec. What is the longest frame that can be sent on this ring?
- ii. In a token ring the sender removes the frame. What modifications to the system would be needed to have the receiver remove the frame instead, and what would the consequences be?**(Nov 09, 07)**
13. i. Explain any two protocols that resolve the contention for the channel with out any collisions at all?
- ii. A very heavily loaded 1-km-long, 10-Mbps token ring has propagation speed of 200m/sec. Fifty stations are uniformly spaced around the ring. Data frames are 256-bits, including 32 bits of overhead. Acknowledgements are piggybacked onto the data frames and are included as spare bits with the data frames and are effectively free. The token is 8 bits. Is the effective data rate of this higher or lower than the effective data rate of a 10-Mbps CSMA/CD network?
14. i. Discuss about MAC addresses?
- ii. Explain about a bit-map collision free protocol? **(Nov 08)**
15. i. Explain how the token ring is maintained in detail?
- ii. Does the use of wire center have any influence on the performance of a token ring? **(Nov 08)**
16. i. What is the prime difference between a token bus and a token ring?
- ii. A large population of ALOHA users manages to generate 50 requests/sec, including both originals and retransmissions. Time is slotted in the units of 40 msec.
- a. What is the chance of success on the first attempt?
 - b. What is the probability of exactly k collisions and then a success?
 - c. What is the expected number of transmission attempts needed? **(Nov 08)**
17. i. Explain five key Assumptions in Dynamic channel allocation in LANs and MANs.
- ii. Explain the multiple access protocol using which the stations about their transmissions as soon as they detect a collision? **(Feb 08, 07, Nov 07)**
18. i. Explain static channel allocation in LANs and MANs.
- ii. Explain five key Assumptions in Dynamic channel allocation MAN **(Feb 08)**
19. i. Explain in detail the operation of slotted ALOHA **(Feb 08)**

- ii. Consider the delay of pure ALOHA versus slotted ALOHA at low load. Which one is less? Explain your answer.
20. i. What is meant by contention systems. **(Feb 08)**
 ii. Explain CSMA/CD protocol.
 iii. Explain any one Collision free protocol.

UNIT V

- 1. i. Discuss about Virtual LAN?
 ii. Why is SONET called a synchronous network? Discuss the functions of each SONET layers? **(Nov 13)**
- 2. i. Write the functions of AAL Layer in ATM Protocol.
 ii. Write short notes ATM Networks. **(Nov 13)**
- 3. Describe the AAL1 and AAL2 Layers in ATM Protocol. **(Nov/Dec 13)**
- 4. i. Explain the significance of Backbone Networks.
 ii. What is virtual LAN ? Explain. **(Dec 12)**
- 5. i. Discuss about transmission in ATM Networks?
 ii. Discuss the importance of electromagnetic spectrum in communication? **(Nov 10)**
- 6. i. What is Pay load? What is the payload size of the maximum length message that fits in a single AAL 3/4 cell?
 ii. When a 1024 bytes message is sent with AAL 3/4, what is the efficiency obtained? In other words, what fraction of the bits transmitted are useful data bits? Repeat the problem for AAL 5 **(Nov 10).**
- 7. Discuss about the functions of ATM layers and Sub layers? **(Nov 09)**
- 8. i. What are the reasons for choosing cell switching in ATM?
 ii. Discuss about the ISDN architecture in detail. **(Nov 09)**
- 9. i. How connections are setup and released in ATM?
 ii. What is the Format for routing table in ATM? How it helps in routing cells? **(Nov 09)**
- 10. i. Any V.C. subnet delivers packets in order, but why Datagram subnet fails to deliver packets in order.
 ii. For request-reply type of service which one is preferred connection oriented service/connection less service. Why?

- ii. Among VC subnet and datagram subnet, which one maintains state information and why? **(Nov 09)**
11. i. Can AAL 1 handle messages shorter than 40 bytes using the scheme with the Pointer field? Explain your answer.
- ii. Suppose that you are measuring the time to receive a TPDU. When an interrupt occurs, you read out the system clock in milliseconds. When the TPDU is fully processed, you read out the clock again. You measure 0 msec 270,000 times and 1 msec 7,30,000 times. How long does it take to receive a TPDU?
 - iii. What is the payload size of the maximum length message that fits in a single AAL 3/4 cell? **(Nov 09,07)**
12. i. What is the format of Cell in ATM?
- ii. Compare Permanent V.C. with Switched V.C. in ATM.
 - iii. How fixed size cells increases the speed of switching? **(Nov 08)**
13. i. How connections are setup and released in ATM?
- ii. What is the Format of routing table in ATM? How it helps in routing cells? **(Nov 08)**
14. Discuss about the file key assumptions in case of dynamic channel allocation in LANs and WANs? **(Nov 08)**
15. i. Define Virtual circuit and datagram. Compare Virtual circuit subnet with datagram subnet.
- ii. Is Virtual circuit same as Physical connection. Comment **(Feb 08)**

UNIT VI

1. i. Discuss about the shortest path routing.
- ii. Explain the Network layer in the internet. **(Nov 13)**
2. i. Explain the shortest path routing algorithm.
- ii. Write about the Broad casting and Multi casting with examples. **(Nov/Dec 13)**
3. i. What are the differences between classful addressing and classless addressing in IPv4. Briefly define subnetting and Supernetting?
- ii. Give the advantages of hierarchical routing.
 - iii. Explain the Open Shortest Path First (OSPF) routing protocol. **(Nov 13)**
4. i. Explain tunneling procedure used in network layer.
- ii. List and distinguish the various uni-cast routing protocols. **(Dec12)**

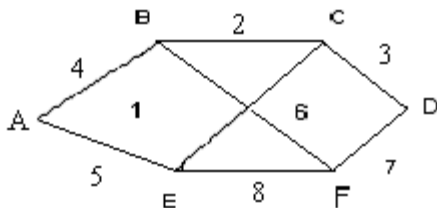
5.
 - i. What is Logical address and Physical address in computer networks? Why a mapping from logical address to physical address and vice versa is required? Explain the protocols which perform it.
 - ii. Explain Special IP address. **(Nov 11)**

6.
 - i. How Tunneling helps in connecting two different networks?
 - ii. How routing in inter-network is different from routing in subnet? **(Nov 11)**

7.
 - i. What is flooding. How flooding can be used for routing packets. In what situations flooding is used or preferred. What is the major disadvantage of flooding. Suggest solutions for it.
 - ii. Among all routing algorithms, flooding results in shortest delay. Comment. **(Nov 11)**

8.
 - i. Compare point-to-point channels with broadcast channels along with suitable examples.
 - ii. A collection of five routers is to be collected in a point-to-point subnet. Between each pair of routers, the designers may put a high speed line, a medium-speed line, a low-speed line, or no line. If it takes 100ms of computer time to generate and inspect each topology, how long will it take to inspect all of them to find the one that best matches the expected load? **(Nov 11)**

9.
 - i. Explain Dijkstra's shortest path algorithm.
 - ii. Consider graph given figure. Compute the shortest path from A to D **(Nov 10)**



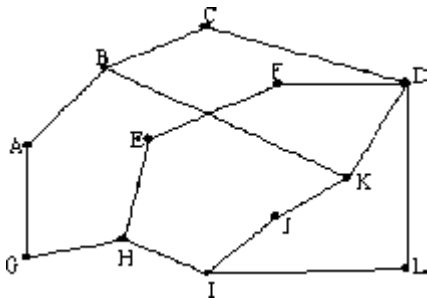
10. What is adaptive routing. Is Distance vector routing adaptive algorithm or not. Justify your answer. Explain in detail distance vector routing. **(Nov 10, 09,08)**

11. When RARP is required. Explain how it works. What is the limitation of RARP? How BOOTP provides solution for it? **(Nov 10)**

12.
 - i. How the complexity at Network layer & transport layer varies with connection oriented and connectionless service.
 - ii. Suppose network layer provides connection less service, transport layer connection oriented service, when low reliability is achieved? **(Nov 10)**

13.
 - i. Why IPv6 uses extended headers? Explain different IPv6 extension headers.
 - ii. What are the advantages of IPv6 over IPv4? **(Nov 10)**

14. i. What is the difference between classful addressing and classless addressing. How classless addressing results in decrease in the table size?
 ii. Give an argument why the leaky bucket algorithm should allow just one packet per tick, independent of how large the packet is. **(Nov 10)**
15. i. Explain the pros and cons of an organization using Class A, Class B & Class C addresses.
 ii. Discuss the difficulties with using actual time in the TTL field
 iii. Describe a way of reassembly of IP fragments at the destination. **(Nov 09)**
16. i. Explain how service differentiation can be achieved using type of service field.
 ii. The IP header checksum only verifies the integrity of IP header. Discuss the pros and cons of doing the checksum on the header part versus on the entire packet.
 iii. Identify the range of IPv6 addresses spanned by Class A, Class B and Class C. **(Nov 09, 08)**
17. i. For hierarchical routing with 4800 routers, what region and cluster sizes should be chosen to minimize the size of the routing table for a three-layer hierarchy?
 ii. Compute a multicast spanning tree for router C in the subnet below for a group with member at routers A, B, C, D, E, F, I, and K. Shown in figure **(Nov 09)**



18. i. What is Multicasting? How is it different from broadcasting? How do you construct a multicast tree? Explain with an example.
 ii. What are the applications of multicasting. **(Nov 09)**
19. i. With an example, explain Distance Vector Routing algorithm?
 ii. Explain about count-to-infinity problem? What is split horizon Hack? **(Nov 09)**
20. i. What is multicasting? How IP supports multicasting?
 ii. What is the advantage of exchanging exact path in BGP?
 iii. Why BOOTP is preferred over RARP? **(Nov 09)**
21. What is non- adaptive routing. Explain any two non- adaptive routing algorithms.

(Nov 08)

22. Define route. Why routing algorithm is required. Routes can be predetermined and then use them when required (or) Routes can be determined when needed and use them immediately. First method is proactive and second method is reactive. Which one is preferred for wired networks? Justify your answer. (Nov 08)
23. What are the services provided by Network layer to Transport layer. Explain. (Nov 08)
24. i. Imagine a generalized n-army problem, in which the agreement of any two of the armies is sufficient for victory. Does a protocol exist that allows blue to win?
ii. Suppose that the clock-driven scheme for generating initial sequence numbers is used with a 15-bit wide clock counter. The clock ticks once every 100msec, and the maximum packet lifetime is 60sec. How often need resynchronization take place
i. in the worst case?
ii. when the data consumes 240 sequence numbers/min?
iii. Why does the maximum packet lifetime, T, have to be large enough to ensure that not only the packet, but also its acknowledgements, have vanished? (Feb 08)
25. i. What are the problem which caused demise of distance vector routing? Explain the algorithm that replaced it?
ii. With an example, explain Distance Vector Routing algorithm? (Nov 09, Feb 08)

UNIT VII

1. What are the various Transport Services, describe them. (Nov/Dec 13)
2. i. Explain the Integrated Services QoS model.
ii. What are the header fields in TCP segment header that are required for flow and congestion control? Explain how these fields are used for flow and congestion control. (Nov 13)
3. i. Explain TCP congestion control protocols.
ii. Compare the two transport protocols-TCP and UDP. (Dec 12)
4. i. How the complexity at Network layer & Transport layer varies with connection oriented and connectionless service?
ii. Suppose Network layer provides connection less service, Transport layer connection oriented service, then how reliability is achieved?
iii. How Virtual circuit is different from Physical connection? (Nov 11).
5. i. How congestion is controlled in V.C. subnets?
ii. What is Choke packet? How does the choke packets helps in congestion control?(Nov 11).
6. i. Explain the transport service primitives.

- ii. Imagine that a two-way handshake rather than a three-way handshake were used to set up connections. In other words, the third message was not required. Are deadlocks now possible? Give an example or show that none exist. **(Nov 11).**
- 7. i. How TCP connections are established?
ii. Draw the finite state machine diagram for connection establishment of TCP and explain different states of the finite state machine.
- 8. i. How RSVP helps in congestion control for multicasting?
ii. How ACK policy at Data link layer affects congestion control? **(Nov 11).**
- 9. i. How control at Transport layer is different from the control at Data link layer?
ii. What is buffering? Give the Pros and Cons of fixed sized & variable sized buffers.
iii. Compare buffering at sender with buffering at receiver. **(Nov 11).**
- 10. i. In TCP why three-way handshake is required for connection establishment and release.
ii. Why TCP is not suitable for request-reply type of transfers?
iii. As application developer under what circumstances you use TCP and under what circumstances you use UDP? **(Nov 10).**
- 11. i. What are the header fields in TCP segment header that are related to only data transfer? Explain?
ii. What are the header fields in TCP segment header that are required for connection establishment and release? explain. **(Nov 09)**
- 12. i. Imagine that a two-way handshake rather than a three-way handshake were used to set up connections. In other words, the third message was not required. Are deadlocks now possible? Give an example or show that none exist.
ii. Explain in detail Four protocol scenarios for releasing a connection. **(Nov 09)**
- 13. i. Network layer can provide both connection oriented service and connection less service. Similar is the case with Transport layer, then why two different layers are required.
ii. What are the Transport layers Quality of service parameters? **(Nov 09)**
- 14. i. What is forbidden region? Explain three-way handshake protocol used for establishing connection.
ii. Explain in detail Four protocol scenarios for releasing a connection. **(Nov 09,07)**
- 15. i. Why Pseudo header is used in computing TCP Checksum?
ii. Explain how TCP controls congestion? **(Nov 08)**
- 16. i. What is the role played by threshold value in congestion control?

- ii. Assume network with links having abundant bandwidth. What are the pros and cons of using exponential increase and linear increase of congestion window? What happens if bandwidth is limited?
 - iii. Explain how flow control is different from congestion control. **(Nov 08)**
17. i. What are the different flags in TCP segment? Explain each of them.
- ii. How TCP uses sliding window to achieve flow control? **(Nov 08)**
18. i. Explain the techniques for controlling packet life time.
- ii. What is forbidden region? Explain how sequence numbers are given to TPDUs. **(Nov 08)**
19. i. Give the format of UDP segment and TCP segment? Explain when UDP is preferred to TCP?
- ii. Briefly discuss about TCP timer management? **(Feb 08, Apr 06)**
20. i. Give the format of UDP segment and TCP segment? Explain when UDP is preferred to TCP?
- ii. What are blocking calls, primitives and non-blocking primitives?
 - iii. Briefly discuss about TCP timer management. **(Feb 08, Apr 06)**
21. i. Explain Berkeley socket primitives for TCP.
- ii. Briefly explain the concept of Addressing in TL. **(Feb 08)**
22. i. Briefly explain the concepts of Flow Control and Buffering.
- ii. What is multiplexing? Briefly explain upward and downward multiplexing. **(Feb 08)**
23. i. Define the following terms.
- a. Option Negotiation
 - b. Transport quality
 - c. Transport service user
 - d. Transport service provider
- ii. Explain in detail Four protocol scenarios for releasing a connection. **(Feb 08)**
24. i. What is the role played by threshold value in congestion control?
- ii. Assume network with links having abundant bandwidth. What are the pros and cons of using exponential increase and linear increase of congestion window? What happens if bandwidth is limited? **(Feb 08)**

UNIT VIII

1. i. Write short notes on SNMP.
- ii. Write short notes on Multi Media transfer in Networks. **(Nov/Dec 13, Nov 09)**
2. i. What is the use of DNS? Explain how it works?
- ii. Explain the basic principles of cryptography.

- iii. What is e-mail? Briefly discuss about the User Agent. **(Nov 13)**
3. Write brief notes on:
- i. Electronic Mail
 - ii. HTTP
 - iii. PSTN. **(Dec 12)**
4. DNS uses databases. Database can be centralized or distributed. What are the pros and cons of centralized and distributed data base approaches. What type of database DNS actually uses? **(Nov 11)**
5. What are the implications of network security for individual privacy and society in general? **(Nov 11)**
6. How Authentication is implemented using Kerberos? **(Nov 10)**
7. What is Digital Signature? Explain the following Digital Signature approaches.
- i. Digital signatures with Big brother
 - ii Digital Signature with Public key cryptography. **(Nov 10)**
8. i. What is substitution cipher? How it works? Using statistical properties howdo you break cipher text.
- ii. How transposition ciphers are different from substitution ciphers? Explain the columnar transposition with example. **(Nov 10)**
10. Explain the architecture and services of e-mail system. **(Nov 09)**
11. i. What are the advantages of using e-mail gateways?
- ii. How SMTP protocol works? **(Nov 09)**
12. i. What is public key cryptography? With an example, Explain RSA Algorithm.
- ii. Explain Diffie-Hellman key exchange Authentication protocol. **(Nov 09, Feb 08, 07)**
13. i. With the help of diagram explain the encryption model.
- ii. What is the role of key secrecy and algorithm secrecy in security?
- iii. What are the approaches for cryptanalysis? **(Nov 08)**
14. i. What is security? What is network security? What is information security? How network security and information security are related?
- ii. What are the Prons and Cons of providing security?
- iii. Who are the people who cause security problems? **(Nov 08)**
15. i. In E-mail system, where the E-mail messages are stored and why?
- ii. Explain any browser of your choice? **(Nov 08)**
16. Explain in detail DES and AES. **(Nov 08)**

17. i. Explain in detail methods of DES chaining.
ii. Briefly discuss about IDEA. **(Feb 08, May 04)**
18. i. What is Cryptanalysis? Briefly discuss about substitution cipher, transposition ciphers and one-time pads.
ii. Explain any one secret key algorithm. **(Feb08, Aug06)**

7.1.14 Assignment Question

Unit I

1. Explain the function of various layers of OSI model.
2. i. Explain about different categories of topology
ii. Give an example where we require.
 - a. Simplex communication
 - b. Half duplex communication
 - c. Full duplex communication
3. i. Briefly explain about the TCP/IP reference model.
ii. Compare and contrast OSI and TCP/IP models.
4. i. What are the various applications of Computer Networks?
ii. What are the advantages of multipoint connection over a point-to-point connection? What are some of the factors that determine whether a communication system is a LAN, MAN or WAN?
5. Why network software is designed based on layer model? Discuss the advantages and disadvantages of the layer model.

Unit II

1. Distinguish between Synchronous and Statistical Time Division Multiplexing
2. Describe the SS7 Service and its relation to telephone network.
3. Discuss circuit switching and packet switching methods. Also discuss their merits and demerits.
4. Discuss in detail about Time division switches?
5. i. What is the difference between single mode and multi mode fibers in fiber optic networks?
ii. What are the different categories of twisted pairs and explain each.
iii. Write about broadband coaxial-cable.

Unit III

1. Write about encoding and decoding procedure used in cyclic codes and checksum with examples.
2. Discuss about character stuffing and bit stuffing framing techniques with examples. Mention their advantages and disadvantages.
3. Mention and discuss the functioning of data link layer protocols in detail.
4.
 - i. Draw and explain about HDLC protocol.
 - ii. Draw and explain point-to-point protocol.
5. Compare and Contrast Stop and Wait, Go back N and Selective Repeat ARQ.

Unit IV

1. Compare and Contrast Controlled access protocol with Channelizing protocol.
2. Define random access protocol and list the protocols with category
3. Discuss about fast Ethernet cabling.
4. Give the detailed description of 802.3 and 802.11 frame format.
5. Write Short notes on Connecting Devices.

Unit V

1.
 - i. Explain the significance of Backbone Networks.
 - ii. What is virtual LAN ? Explain.
2. Write about wireless WANS briefly
3. Discuss about transmission in ATM Networks
4. Compare Permanent V.C. with Switched V.C. in ATM.
5. Discuss function of each SONET layer and what is the relation between STS and STM?

Unit VI

1. What is Logical address and Physical address in computer networks? Why a mapping from logical address to physical address and vice versa is required? Explain the protocols which perform it.
2. What is the difference between classful addressing and classless addressing. How classless addressing results in decrease in the table size?
3.
 - i. Explain about IPv4 internet protocol.
 - ii. What are the advantages of IPv6 over IPv4?
4.
 - i. with an example, explain Distance Vector Routing algorithm?
 - ii. Explain about count-to-infinity problem? What is split horizon Hack?
5.
 - i. What is multicasting? How IP supports multicasting?
 - ii. What is the advantage of exchanging exact path in BGP?
 - iii. Why BOOTP is preferred over RARP?

Unit VII

1. i. Explain TCP congestion control protocols.
ii. Compare the two transport protocols-TCP and UDP.
2. Give an argument why the leaky bucket algorithm should allow just one packet per tick, independent of how large the packet is.
3. i. How congestion is controlled in V.C. subnets?
ii. What is Choke packet? How does the choke packets help in congestion control?
4. i. In TCP why three-way handshake is required for connection establishment and release.
ii. Why TCP is not suitable for request-reply type of transfers?
5. Write Short notes on SCTP.

Unit VIII

1. Write brief notes on:

i. Multimedia

ii. HTTP

iii. WWW

2. What is SNMP? Briefly discuss the SNMP model components.

3. What are the pros and cons of centralized and distributed data base approaches. What type of database DNS actually uses.

4. i. What are the advantages of using e-mail gateways?

ii. How SMTP protocol works?

5. i. What is security? What is network security? What is information security? How network security and information security are related?

ii. What are the Pros and Cons of providing security?