Ref No: Ex/IT/PC/B/T/225/2022

Bachelor of Information Technology 2nd Year 2nd Semester Examination 2022

Sub: Computer Networks

Full Marks: 100 Time: 3 hours

Answer either (a) or (b) from each question

Answers must be brief and to the points

1.

a. (3+5+3+5)

i. Suppose all laptops in a large city are to communicate using radio transmissions from a high antenna tower. Is the data link layer or network layer more appropriate for this situation? Now suppose the city is covered by a large number of small antennas covering smaller areas. Which layer is more appropriate?

ii. Two networks each provide reliable connection-oriented service. One of them offers a reliable byte stream and the other offers a reliable message stream. Are these identical? If so, why is the distinction made? If not, give an example of how they differ.

iii. If the data link layer can detect errors between hops, why do you think that we need another checking mechanism at the transport layer?

iv. You are given a communication link that transmits R bits per second. The objective is to transmit a file of length L bits. The bits are sent in packets; P bits of the file are sent in each packet, except for the last which contains all the leftover bits. A header of length H bits is added to each packet before it is transmitted over the link. Consecutive packets must be separated by at least G seconds. Derive an expression for the total time to transmit the file.

b. (3+3+4+3+3)

i. Protocol Independence is an important issue. Why? Find out where this important issue is ignored in the Internet.

ii. Can a connection oriented, reliable message transfer service be provided across a connectionless packet switched network? Explain.

iii. When transferring a file between two computers, two acknowledgement strategies are possible. In the first one, the file is chopped up into packets, which are individually acknowledged by the receiver, but the file transfer as a whole is not acknowledged. In the second one, the packets are not acknowledged individually, but the entire file is acknowledged when it arrives. Discuss the two approaches.

iv. Is the data link layer necessary even if there were no bit errors or losses at the physical layer? Why or Why not?

v. Suppose that the transport layer protocol receives a 1.5 megabytes file from the application layer and that the network layer protocol is willing to carry a block of maximum size 1500 bytes including protocol header overhead of 60 bytes. Calculate the amount of overhead incurred from segmenting the file into packet sized units.

2.

a. (4+7+3+2)

Suppose that a Stop-and-Wait ARQ system has a timeout value that is less than the time required to receive an acknowledgement. Sketch the sequence of frame exchanges that transpire between two stations when station A sends five frames to station B and no error occur during transmission.

ii. To understand the effect of window size on the performance of sliding window protocol, consider an error free channel of 1 Mbps with 20 msec propagation delay. The frame size is 256 bytes with negligible header. Acknowledgement frames can be ignored. Calculate the performance of sliding window protocol for window sizes varying from 1 to 32 in steps of 7 and plot them.

iii. If the available maximum sequence number is 13, compute sender and receiver window sizes in go-back-n and selective repeat.

iv. We almost always put the CRC at the end of a frame. What advantage do we get from this policy?

16

b. (8+3+5)

i. A colony is set up in moon. The 10 Mbps link from the earth to the lunar colony measures about 242000 miles. Assume that the signal propagation speed is 186000 miles per second. Calculate the minimum round-trip time (RTT) for the link. Calculate the delay*bandwidth product for the link. If a camera on the lunar base sends 25 Mbyte image file to the earth as a sequence of 1 Kbyte packets, how many bits are needed for the sequence number if we assume the use of a sliding window protocol? What is the window size and buffer size at both sender and receiver?

ii. A received polynomial can always be considered as the original polynomial plus the erroneous polynomial in the CRC. Explain.

iii. Suppose that instead of Go-Back-N ARQ, N simultaneous Stop-and-Wait ARQ processes are run in parallel over the same transmission line. Each frame is assigned to one of the N processes that is currently idle. The processes that have frames to send take turns transmitting in round-robin fashion. The frames carry the sequence number as well as an ID identifying which ARQ process the frame belongs to. How does the service offered by this protocol differ from the service offered by Go-Back-N ARQ?

3.

a. (8+4+5+3)

20

i. In a TDM medium access control bus LAN, each station is assigned one time slot per cycle for transmission. Assume that the length of each time slot is the time to transmit 100 bits plus the end-to-end propagation delay. Assume a propagation speed of $2*10^8$ m/sec. The length of the LAN is 1 km with a bandwidth of 10 Mbps. Find out the maximum number of stations that can be allowed in the LAN so that the throughput of each station can be $\frac{2}{3}$ Mbps.

ii. Ethernet frames must be at least 64 bytes long to ensure that the transmitter is still going in the event of a collision at the far end of the cable. Fast Ethernet has the same 64 byte minimum frame size, can get the bits out ten times faster. How is it possible to maintain the same minimum frame size?

iii. Suppose two 10 Mbps Ethernet LANs each containing N/2 stations are connected by a bridge. Assume that the efficiency of each Ethernet is 80 percent. Also assume that each station transmits frames at the average rate of 100 Kbps and each frame is equally likely to be destined to any station. What is the maximum number of stations N that can be supported in this extended Ethernet?

iv. Consider a token ring network with a length of 2km having 10 stations including a monitoring station. The propagation speed of the signal is 2×10^8 m/s and the token transmission time is ignored. If each station is allowed to hold the token for 2 μsec, what is the minimum time for which the monitoring station should wait before assuming that the token is lost?

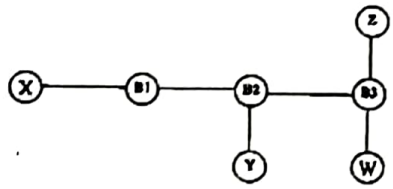
b. (9+3+4+4)

i. Consider a 30 station, 10 Mbps token passing bus system in which there are 15 active stations on average in any round of token passing. If the token is passed explicitly as a separate control packet with 10% size of the data frame, what are the channel utilizations and average token rotation time for the best and worst case of token passing? Consider the data frame to be 1500 bytes and the end-to-end propagation delay to be 10μs.

ii. In LAN A 10 computers are connected using hub and in LAN B using switch. Which LAN do you prefer and why?

iii. The IT department of J.U. has 3 Ethernet segments, connected by two transparent bridges into a linear network. One day the network administrator quits and is replaced by a person from computer center who is an expert in token ring. The new administrator, noticing that the ends of the network are not connected, quickly orders a new transparent bridge and connects both loose ends to it, making a closed ring. What happens next?

iv. Consider hosts X, Y, Z, W and learning bridges B1, B2, B3 with initially empty forwarding tables as shown in the following figure.



i. Suppose Y sends to X. Which bridges learn where Y is? Does Z's network interface see this packet?

ii. Finally, suppose W sends to Z. Which bridges learn where W is? Does Z's network interface see this packet?

4.

a. (4+5+3+2+6)

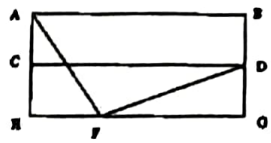
i. What are the two approaches to packet switching? Distinguish between them.

ii. A computer on a 6-Mbps network is regulated by a token bucket. The token bucket is filled at a rate of 1 Mbps. It is initially filled to capacity with 8 megabits. How long can the computer transmit at the full 6 Mbps?

iii. Suppose that a datagram network has a routing algorithm that generates routing tables so that there are two disjoint paths between every source and destination that is attached to the network. Identify the benefits of this approach. What problems are introduced with this approach?

iv. A subnet is using link state routing algorithm with 16 bit sequence number for the link state packets. If a link state packet is sent every second, how long would it take before wrap around occurs. Assume starting sequence number is 0.

v. For the network given below, the routing table of the four nodes A, E, D, and G are shown. Suppose that F has estimated its delay to its neighbors A, E, D, and G as 8, 10, 12, 6 msec respectively and updates its routing table using Distance Vector Routing algorithm. Find the routing table for router F.



Destinations	Table for A	Table for E	Table for D	Table for G
A	0	24	20	21
B	40	27	8	24
C	14	7	30	22
D	17	20	0	19
E	21	0	14	22
F	9	11	7	10
G	24	12	22	0

b. (2+3+5+5+5)

i. One reason for introduction of link state routing in place of distance vector routing is the growing size of the Internet. Why?

ii. Why connectionless service is less efficient to stop congestion setting up, but better to have when congestion set up?

iii. As a possible congestion control mechanism in a network using virtual circuits internally, a router could refrain from acknowledging a received packet until (1) it knows its last transmission along the virtual circuit was received successfully and (2) it has a free buffer. For simplicity, assume that the routers use a stop-and-wait protocol and that each virtual circuit has one buffer dedicated to it for each direction of traffic. If it takes T sec to transmit a packet (data or acknowledgement) and there are n routers on the path, what is the rate at which packets are delivered to the destination host? Assume that transmission errors are rare and that the host-router connection is infinitely fast.

iv. For a host machine that uses the token bucket algorithm for congestion control, the bucket has a capacity of 1 megabytes and the maximum output rate is 20 megabytes per second. Tokens arrive at a rate to sustain output at a rate of 10 megabytes per second. The machine needs to send 12 megabytes of data. What is the minimum time required to transmit entire data?

v. Below are the link state packets generated by routers in a subnet. What is the shortest distance between A and D?

A		B		C		D		E		F	
Seq		Seq		Seq		Seq		Seq		Seq	
Age		Age		Age		Age		Age		Age	
B	4	A	4	B	2	C	3	A	5	B	6
E	5	C	2	D	3	F	7	C	1	D	7
		F	6	E	1			F	8	E	8

5.

a. (8+2+2+4) 16

i. Suppose P, Q, and R are network service providers with respective CIDR address allocations C1.0.0.0/8, C2.0.0.0/8, and C3.0.0.0/8. Each providers customers initially receive address allocations that are a subset of the provider's.

P has the following customers:

PA, with allocation C1.A3.0.0/16

PB, with allocation C1.B0.0.0/12

Q has the following customers:

QA, with allocation C2.0A.10.0/20

QB, with allocation C2.0B.0.0/16

Assume there are no other providers or customers:

1. Give routing table for P, Q, and R assuming each provider connects to both of the other.
2. Now assume P is connected to Q and Q is connected to R, but P and R are not directly connected. Give tables for P and R.

ii. IP, ARP, IGMP and ICMP all run in network layer. How does a computer know if an arriving frame contains an IP datagram or an ARP message or an IGMP packet or an ICMP packet?

iii. Can we use a single bit subnet? Explain.

iv. A router has the following routes in its routing table:

Route	Outgoing Interface
10.0.0.0/8	E0
10.0.0.0/16	E1
10.0.1.0/24	S0
10.1.1.0/24	S1
10.1.0.0/16	S0
10.1.0.0/24	E1
10.1.1.1/32	S2

A packet arrives at the router with a destination address of 10.1.1.1. Which interface will the router use to forward that packet?

b. (6+4+4+2)

i. An organization has been assigned the prefix 212.1.1.0/24 and wants to form subnets for four departments, with hosts as follows:

A 75 hosts

B 35 hosts

C 20 hosts

D 18 hosts

1. Give a possible arrangement of subnet masks to make this possible.
2. Suggest what the organization might do if department D grows to 32 hosts.

ii. Suppose a router receives 600 bytes IP packet and has to forward the packet to a network with MTU of 200 bytes. Assume that the IP header is 20 bytes. Show the fragments that the router creates and specify the relevant values in each fragment header.

iii. Perform CIDR aggregation on the following IP addresses: 16.27.24.0/26; 16.27.24.64/26; 16.27.24.128/25.

iv. Computer A sends a packet to computer B with port number 1000. There is no process running at port number 1000 in computer B. What action computer B will take?

12

6.

a. (2+3+4+3)

i. When we say that the transport layer multiplexes and de-multiplexes application layer messages, do we mean that a transport layer protocol can combine several messages from the application layer in one packet? Explain.

ii. A sender and receiver communicate using TCP. If the MSS is 1500 bytes, draw a diagram showing how long it takes to transfer 15000 bytes.

iii. You are hired to design a reliable byte-stream protocol that uses a sliding window (like TCP). This protocol will run over a 1-Gbps network. The RTT of the network is 100ms, and the maximum segment lifetime is 30 seconds. How many bits would you include in the window size and sequence number fields of your protocol?

iv. Define the purpose of the following fields in TCP header:

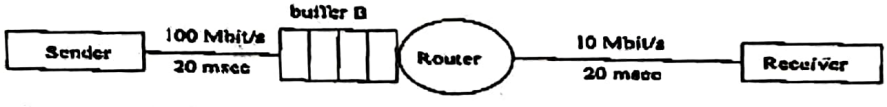
RST, PSH, FIN

b. (2+2+3+5)

i. In addition to having acknowledgement field in the TCP header, ACK bit is also provided. What would happen if the ACK bit were not provided?

ii. Why do we use delayed acknowledgement and how?

iii. In the network shown in Figure below, we would like a TCP connection to fully utilize the bottleneck link. What should we make the size of buffer B? Assume that the advertised receiver window is very large. The link latencies given are one-way.



iv. Consider a window controlled transfer over a connection with a RTT of 200 ms. The bottleneck link speed on the path is 2 Mbps. The data packet length is 1000 bytes. Assume that there is only one connection over the bottleneck link.

a. Determine the minimum window (in number of packets) required so that the bottleneck link is fully utilized (ignore the ACK transmission times).

b. If a window of 20 packets is used, determine the maximum possible utilization of the bottleneck link.

c. What happens if a window of 80 packets is used?