Ref. No.: Ex/PG/ITE/PC/T/112/2025

Jadavpur University
Department of Information technology
M.E. Information Technology 1st Year 1st Semester - 2025
Subject: Networking and Internet Technologies

Time: 3 Hours Full Marks: 100

(Note: Answer must be brief and to the point, and answers of all parts of a question should be written together)

Attempt any ***five*** questions

Q.1

a. Suppose that x bits of user data are to be transmitted over a k-hop path in a packet switched network as a series of packets, each containing p data bits and h header bits with $x>>p+h$. The bit rate of the line is b bps and propagation delay is negligible. What value of p minimizes the total delay?
b. Consider a router in the backbone of the Internet. Assume that the router has 24 ports, each attached to a 1Gbps link. Say that each link is used at 15% of its capacity by connections that have an average throughput of 200kbps. How many connections go through the router at any given time? Say that the connections last an average of 1 minute. How many new connections are set up that go through the router in any given second, on average?
c. There are 10 stations in a time slotted LAN always having constant load and ready to transmit. During any particular contention slot each station transmits with a probability of 0.1. If the average frame takes 122 ms to transmit, what is the channel efficiency, if round trip time is 51.2 micro seconds?
d. Discuss the similarities between the following nation transportation network and a communication network.
i) Railroad Network, and ii) Highway System
e. Protocol Independence is an important issue. Why? Find out where this important issue is ignored in the Internet.

5+5+4+4+2

Q.2

a. Consider a bidirectional link that uses Go-Back-N with N = 3. Suppose that frames from station A to Station B are one unit long and use a timeout value of 2. Frames in the opposite direction are 2.5 units long and use a timeout value of 4. Assume that propagation and processing times are negligible, that the stations have an unlimited number of frames ready for transmission, and that all acknowledgements are piggybacked onto data frames. Assuming Station A and B begin with their sequence numbers set to zero, show the sequence of frame transmissions assuming no transmission errors.
b. 1.5 Mbps communication link uses HDLC to transmit information to the moon. What is the smallest possible frame size that allows continuous transmission? The distance between earth and the moon is approximately 375000km, and the speed of signal propagation is $3x10^8$ m/s.
c. Compare the operation of Stop-and-Wait ARQ and bidirectional Go-Back-N ARQ with a window size of 1. Sketch out a sequence of frame exchanges using these protocols and observe how the protocols react to the loss of information frame and to the loss of acknowledgement frame.
d. A sender and a receiver use a Sliding window protocol with 5-bit sequence number. The sequence number starts from 0. What is the sequence number after sending 100 frames?
e. Find the CRC for data stream 1010101010 using generator 10011.

4+4+5+3+4

Q.3

a. Let's consider the operation of a learning switch in the context of a network in which 6 nodes labeled A through F are star connected into an Ethernet switch. Suppose that (i) B sends a frame to E, (ii) E replies with a frame to B, (iii) A sends a frame to B, (iv) B replies with a frame to A. The switch table is initially empty. Show the state of the switch table before and after each of these events. For each of these events, identify the link(s) on which the transmitted frame will be forwarded, and briefly justify your answers.
b. Determine the maximum length of cable (in km) for transmitting data at a rate of 500Mbps in an Ethernet LAN with frame size of 10000 bits. Assume the signal speed in the cable to be 200000 km/sec.
c. A disadvantage of broadcast subnet is the capacity wasted due to collisions. Suppose the time is divided into discrete slots with each of the n hosts attempting to use the channel with probability p during each slot. What fraction of the slots is wasted due to collisions?
d. Suppose a group of 10 stations is serviced by an Ethernet LAN. How much bandwidth is available to each station if:
    i) The 10 stations are connected to a 10 Mbps Ethernet Hub.
    ii) The 10 stations are connected to a 10 Mbps Ethernet switch.
e. What advantage do you get by using binary exponential back off instead of fixed back off interval?

6+4+4+4+2

[Turn over

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Q.4

a. We would like to transfer 20 KB file across a network from node A to node F. Packets have a length of 1KB (neglecting header). The path from node A to node F passes through 5 links, and 4 intermediate nodes. Each of the links is a 10 Km optical fiber with a rate of 10 Mbps (assume speed of light in optical fiber is 2.0x108m/s). The 4 intermediate nodes are store-and-forward devices, and each intermediate node must perform a 50 μs routing table look up after receiving a packet before it can begin sending it on the outgoing link. How long does it take to send the entire file across the network?

b. A 64-kolobyte message is to be transmitted over two hops in a network. The network limits packets to a maximum size of 2-kilobytes, and each packet has a 32-byte header. The transmission lines in the network are error free and have a speed of 50Mbps. Each hop is 1000 km long. How long does it take to get the message from the source to the destination

c. 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?

d. In a network node F has four neighbors A, E, D, and G. The routing table of the four nodes A, E, D, and G are shown. Suppose that F has estimated its delay to A, E, D, and G as 8, 10, 12, and 6 msec respectively and updates its routing table using distance vector routing algorithm. Give the updated routing table of F.

	A	E	D	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	22	22	0

6+4+5+5

Q.5

a. Suppose a TCP message that contains 1024 bytes of data and 20 bytes of TCP header IS passed to IP for delivery across two networks interconnected by routers (i.e., it travels from the source host to a router to the destination host). The first network has an MTU of 1024 bytes; the second has an MTU of 576 bytes. Each network's MTU gives the size of the largest IP datagram that can be carried in a link-layer frame. Give the sizes and offsets of the sequence of fragments delivered to the network layer at the destination host. Assume all IP headers are 20 bytes.

b. What will be the aggregated network prefix and the mask containing four subnets with the network prefixes 57.6.96.0/21, 57.6.104.0/21, 57.6.112.0/21, and 57.6.120.0/21?

c. An organization is granted the block 211.17.180.0/24. The administrator wants to create 32 subnets.
i) What is the subnet mask in x.y.z.t/n notation? ii) What is the range of addresses in first and last subnet? iii) How many addresses are in each subnet?

d. ARP only permits address resolution to occur on a single network. Could ARP send a request to and get a reply from a remote server using an IP datagram? Why does IPv6 allow fragmentation at the source only? How does a newly booted machine acquire IP address from DHCP server in distant network?

6+3+5+(2+2+2)

Q.6

a. The Nagle algorithm, built into most TCP implementations, requires the sender to hold a partial segment's worth of data (even if PUSHed) until either a full segment accumulates or the most recent outstanding ACK arrives. Suppose the letters *abcdefghijkl* are sent, one per second, over a TCP connection with an RTT of 3.1 seconds. Draw a timeline showing when each packet is sent and what it contains.

b. Suppose a user has two browser applications active at the same time and suppose that the applications are accessing the same server to retrieve HTTP documents at the same time. How does the server tell the difference between two applications? Suppose we need a communication service to transmit real time voice over the Internet. What features of TCP and what features of UDP are appropriate? TCP entity opens a connection and uses slow start. Approximately how many round-trip times are required before TCP can send N segments?

c. Suppose you are transferring a file of 10 MB over a network, which has a capacity of 20 MB and 50 msec one-way delay. The packet size used in network is 1 KB. The initial slow start threshold is set to 10 MB. What is the effective throughput achievable for TCP?

d. 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 100 msec, and the maximum segment lifetime is 30 sec. How many bits you include in the window size and sequence number fields of your protocol?

4+(2+2+2)+5+5
