C2-R4: ADVANCED COMPUTER NETWORKS

NOTE:

1. **Answer question 1 and any FOUR from questions 2 to 7.**
2. **Parts of the same question should be answered together and in the same sequence.**

Time: 3 Hours **Total Marks: 100**

1.

a) Prove that maximum throughput of Slotted Aloha occurs at G=1.0 and the maximum achievable throughput is 36.8%.

b) Write down the UDP header format with fields and allocated size.

c) Write short note on Random Early Detection (RED).

d) A network has N-Layer hierarchy. Application generate message of length M bytes. Layer 2 to N, each adds a header of H data bytes to the data unit received from upper layer. What fraction of network bandwidth is filled with headers? Assume that the physical media is never idle.

e) Suppose that you are designing a sliding window protocol for 1MBPS point-to-point link to a geo-stationary satellite above earth at an altitude of 30,000 K.M. Assuming that each frame carries 1 KB of data, what is the minimum of bits you need for the sequence number in the following cases

   i) Receiver window size is 1

   ii) Sender window size = Receiver window size

   (Assume propagation speed of signal is $3x10^8$ m/s).

f) Assume the router has built up the following routing table.

Subnet No.	Subnet Mask	Next Hop
128.96.170.0	255.255.254.0	Interface 0
128.96.168.0	255.255.254.0	Interface 1
128.96.166.0	255.255.254.0	R2
128.96.164.0	255.255.252.0	R3
Default		R4

Where the packets with the destination address (A) to (D) forwarded to?

   i) 128.96.171.92

   ii) 128.96.167.151

   iii) 128.96.163.151

   iv) 128.96.169.192

g) Compare delay in sending a message of length X bits over a path of length K in a circuit switched network and in a lightly loaded packet switched network. The circuit setup time is S sec, propagation delay per hop is D sec., packet length P bits and data rate is B bps. Under what condition does the packet switched network have a lower delay of transmission? Assume X is multiple of P.

(7x4)

2. Suppose users share a 1 Mbps link. Also, suppose each user requires 100Kbps while transmitting. However each node transmits only 10% of their time.

   a) When circuit switching is used how many users can be supported?

   b) If packet switching is used what is probability that a given user is transmitting?

   c) If packet switching is used by all users among N users then what is the probability that exactly K users are transmitting simultaneously?

   d) In light of the calculation made above state, explain whether packet switching or circuit switching is better and why.

(3+5+5+5)

3.

a) What is the difference between delay and packet jitter? What are the causes of jitter?
b) What are the difficulties associated with Intserv model and per-flow reservation?
c) Explain preemptive priority queuing. Why preemptive priority queuing is not applicable in packet switching network?
d) Suppose there are three intermediate routers between a source and destination host. Without considering fragmentation, if an IP datagram is sent from source to destination, how many interfaces will it travel? How many forwarding tables are indexed in this operation?

(5+5+5+3)

4. 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 ms, and the maximum segment lifetime is 30 seconds.

a) How many bits would you include in the **AdvertisedWindow** and **SequenceNum** fields of your protocol header?
b) How would you determine the numbers given above, and which values might be less certain?
c) Suppose a host wants to establish the reliability of a link by sending packets and measuring the percentage that is received. For example, Routers. Explain the difficulty doing this over a TCP connection.
d) Write down the binary equivalent of the IP address 223.1.3.27.

(5+5+5+3)

5.

a) What is count to infinity problem?
b) Consider an arbitrary mesh topology which runs a synchronous version of distance vector routing protocol. Assuming that the algorithm begins with each node knowing only the costs to its immediate neighbours. What is the maximum number of iterations required from the start before all routing table converge?
c) Will the synchronous version of the distance vector routing also suffer from count to infinity problem? If yes then suggest a remedy for the problem. Also state, if there is any limitation in your solution.
d) Why error control mechanism is implemented in both Data-link layer and Transport layer.

(3+5+5+5)

6.

a) State why classless IP addresses are necessary than classful addressing.
b) With an example explain how "**Go-back N**" and "**Selective Retransmission**" works.
c) On a network gateway, measurement show that the packets arrive at a mean rate of 125 packets per second and gateway takes 2ms to forward them. Using M/M/1 model analyze the gateway. What is the probability of buffer overflow if the gateway had only 13 buffers? How many buffers do we need to keep packet loss below one packet per million?

(4+6+[2+3+3])

7.

a) Imagine 2-way handshake rather than 3-way handshake being used to setup a transport layer protocol. In other words the third is not used. What are the problems in such situation if any? Otherwise show that there is none. All necessary timers may be assumed to be present.
b) Why a TCP sender does decreases sending rate more aggressively (on a packet loss) than it increases the sending rate (on successful packet delivery)?
c) The way TCP sender reacts to packet loss depends on how the loss was detected. What are the two scenarios? How does sender adapt rate in each case? Why are these two cases handled differently?

d) A client sends a 128-byte request to a server located 100 km away over a 1-Gigabit optical fiber. What is the efficiency of the line during the remote procedure call?

e) Both UDP and TCP use port numbers to identify the destination entity when delivering a message. Give two reasons for why these protocols invented a new abstract ID (port numbers), instead of using process IDs, which already existed when these protocols were designed.

f) MAC addresses only have significance within the context of a local-area network. So, why are MAC addresses globally unique?

(6x3)