BIRLA INSTITUTE OF TECHNOLOGY & SCIENCE, PILANI
Department of Computer Science & Information Systems
Second Semester 2021-2022
COMPUTER NETWORKS (CS F303)
Comprehensive Examination (REGULAR)

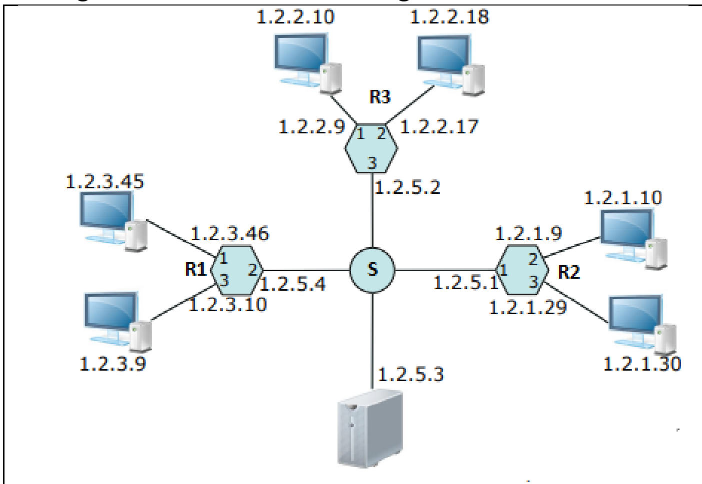
Date of Exam: 19-05-2022 (FN) **PART-B (OPEN BOOK)** **MM: 34** **Duration: 1.5 Hrs.**

Note: Write your answers in the main answer sheet. Attempt subparts of questions in sequence one after the other.

Q.1 A file is transmitted using a TCP connection with Fast Retransmit and Fast Recovery congestion control algorithms. For simplicity, we consider the congestion-window size of the TCP connection in segments instead of bytes and all segments are of same size (equal to MSS). There are total 45 segments (numbered from 1 to 45) are required to be sent to transmit the complete file. Suppose that the original segments with numbers 7, 19, 25, 35, and 36 are dropped during the transmission due to congestion in the network. The Time-Out value for the connection is fixed and it is twice the RTT value. You can assume that sender transmits all segments (allowed as per the congestion control) together (one after the other) in each round of the transmission (one round takes one RTT) and receives individual segment's ACKs within the same RTT for the segments which are successfully received by the receiver. The initial slow-start threshold (ssthrash) value for the connection is 10 MSS. If the result of multiplicative decrease and additive increase is not an integer, then round down it to the nearest integer. If Time-Out and ACK(s) arrival events occur in the same RTT then ACK(s) is processed first.
Depict the complete file transfer process using the TCP connection described above in the following format. Create a similar table in your answer sheet to answer the question. **[10M]**

RTT no. (Data Transmission Round No.)	**1**	**2**	**3**	**4**	**…**
Congestion-window size in segments					
Nos of Segment(s) sent (e.g., 1-4, 2-3, and 6,8,10)					
Value of ssthrash					
Connection State (e.g., Slow-Start/Fast-Recovery/Fast-Retransmit, Congestion-Avoidance, etc.). (Note: Specify RTT/Range of RTT for the connection state.)					

Q.2 The diagram below shows a network with 3 routers (**R1**, **R2**, and **R3**) connected by an Ethernet switch (**S**). The routing table for the **R1** router is given below. **[3+1+2+2+4=12M]**



Routng Table of **R1** Router

Prefix	Next Hop	
	Out-port	IP
1.2.2.8/30	2	1.2.5.2
1.2.1.0/26	2	1.2.5.1
1.2.5.0/24	2	-
1.2.2.16/30	2	1.2.5.2
1.2.3.44/30	1	-
1.2.3.8/29	3	-

a) Write the routing table entries for the **R2** router using the same format as **R1**, so that packets will be delivered appropriately. Use the longest possible prefixes for all routing table entries as per the IP addresses allocated in the respective subnets and make sure that the number of routing table entries are not more than 5.

b) Are all the entries in the **R1** router table necessary? If not, show how to reduce the number of entries, without changing the routing behavior.

c) Suppose we wanted to add a switch at port 1 of the **R1** router, along with 10 new hosts (the existing host would now be connected to the switch, rather than the router). Which routing table entries would have to change as a result? What are the new entries?

d) If a switch was inserted between the host with IP address 1.2.3.9 and its router, how many hosts could be added to that switch, without having to change the routing table entries? What IP addresses would those hosts use?

e) Suppose that the server, with IP address 1.2.5.3 is configured to use the **R2** router for its non-local traffic. Assume that the ARP tables for all hosts and routers are empty initially. List all packets that must be sent from one network-level component to another, in order to deliver a packet from the server to the host with IP address 1.2.2.10. For each packet, specify which component sends it and which receives it and give a brief description. For example, "R1 router to R2 router: ARP request for address xyz", or "Server to R3 router: data packet").

Q.3 Two nodes A and B employing standard 10 Mbps Ethernet (discussed in the class) are competing for access. Suppose, at time t = 0 node A has 2 frames of size 100 Bytes (frame A1) and 120 Bytes (frame A2) respectively and node B has only one frame of 140 Bytes (frame B1) to be transmitted. MAC layer of both nodes A and node B is not receiving any further frame from above layers after time t = 0. Suppose both A and B start transmitting A1 and B1 at the same time t = 0. Obviously, both the transmissions will collide. After this collision the node A and node B choose back off value k = 0 and k = 1 respectively. Next time when A2 collides with B1, A choose k = 0 and B chooses k = 3. Assume one-way propagation delay between node A and node B is 200 bit times. The collision detected at a node as soon as it receives the first bit of the frame transmitted by the other node. The collision will be considered at a node, if the time of receiving the last bit of a frame from other side and the start time of a frame at the node are same. The jam signal is transmitted immediately after collision detection.

The following table provide the sequence of events/actions at both nodes along with their timings/time-interval (bit times). The table is partially filled. Complete the table by filling the cells marked with **(a) to (x)** in your answer sheet. The cell entry NULL represents no event/action happened at that time/interval. **[12M]**

Station A		**Station B**	
Time (t)	**Event/Action**	**Time(t)**	**Event/Action**
0	Transmission of frame A1 starts	0	Transmission of frame B1 starts
(a)	First bit of frame B1 arrives, collision detected, jam signal transmission starts.	**(b)**	First bit of frame A1 arrives, collision detected, jam signal transmission starts.
232	**(c)**	232	**(d)**
(e)	Bits of frame B1 from B continue to arrive.	**(f)**	Bits of frame A1 from A continue to arrive.
400-432	Jam signal from B arriving.	400-432	Jam signal from A arriving.
432	**(g)**	432	**(h)**
(i)	Waiting for inter frame gap.		NULL
(j)	A start retransmission of frame A1		NULL
	NULL	**(k)**	First bit of frame A1 arrives.
	NULL	744	**(l)**
(m)	The last bit of frame A1 is transmitted.		NULL
(n)	Transmission of frame A2 starts.		NULL
	NULL	**(o)**	The last bit of frame A1 is received.
	NULL	1624	**(p)**
	NULL	1624-1656	The bits of A2 continue to arrive.
	NULL	1656	**(q)**
1824	**(r)**		NULL
1856	**(s)**		NULL
1952	**(t)**		NULL
2912	**(u)**		NULL
	NULL	**(v)**	Retransmission of frame B1 is scheduled.
	NULL	3288	**(w)**
	NULL	4408	**(x)**

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