National University of Computer and Emerging Sciences
Lahore Campus

Computer Networks (CS3001)

Sessional-II Exam

Date: November 5th 2025

Course Instructor(s)

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Total Time: 1 Hours
Total Marks: x
Total Questions: x

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Roll No Section Student Signature

Instruction/Notes:
- Attempt all questions on the provided separate answer sheet.
- Clearly write corresponding question number and part number at the top center of the answer sheet with a thick pen / marker before starting a new question / answer.
- In case you have used rough sheets, they should **NOT** be attached to the answer sheet.

CLO 1 (): **Describe** utilization of network protocol concepts vis-a-vis OSI and TCP/IP stack.

Q1: By Ms. Sarah Khaleel 8-10 MCQs from both Chapters

1. A TCP sender has **cwnd = 12 MSS**, **ssthresh = 24 MSS**, and experiences **no loss**. What happens to cwnd after the next RTT in congestion-avoidance phase?
A. 13 MSS
B. 24 MSS
C. 1.5×MSS
D. Remains 12 MSS
Answer: A — cwnd increases linearly by 1 MSS per RTT in congestion-avoidance.

2. A 1500-byte datagram (20-byte header) is fragmented over a link with **MTU = 620 bytes**.
How many fragments are created?
A. 2 B. 3 C. 4 D. 5
Answer: C — Max payload per fragment = 620-20 = 600 B;
1480/600 = 2.466 ⇒ 3 fragments total.

3. TCP uses three duplicate ACKs as a signal for what event?
A. End of connection
B. Congestion avoidance
C. Packet loss detection
D. Timeout expiry

Answer: C — Three duplicate ACKs trigger fast retransmit.

OR

3. A TCP connection's cwnd is 10 MSS, ssthresh is 12 MSS, and a **triple duplicate ACK** occurs.
After fast recovery, cwnd becomes:
A. 10 MSS B. 5 MSS C. 6 MSS D. 8 MSS
Answer: C — cwnd = ssthresh = ½ × 12 = 6 MSS (fast recovery step).
4. In **Go-Back-N**, sender window = 5, sequence numbers = 3 bits.
What's the maximum number of **outstanding unacknowledged frames** at any time?
A. 5 B. 4 C. 7 D. 8
Answer: A — Sender can have up to N unacknowledged = window size = 5.
5. A **Selective Repeat** receiver window = 3.
If packets 0, 1, 2 arrive, and ACK for 0 is lost, what happens?
A. Sender retransmits all
B. Sender times out and retransmits 0
C. Receiver sends duplicate ACKs for 0
D. Receiver waits silently
Answer: B — Timeout causes retransmission of 0 only (independent ACKs).
6. A TCP segment is sent with **seq = 200**, **len = 600 bytes**. What ACK number will the receiver send after successfully receiving it?
A. 600 B. 800 C. 201 D. 601
Answer: B — Ack = Seq + Len = 800.
7. During **slow start**, cwnd = 8 MSS, ssthresh = 10 MSS. After one RTT with no loss, cwnd becomes:
A. 9 B. 10 C. 16 D. 11
Answer: C — Doubles until exceeding ssthresh.
8. In the **rdt 2.2** protocol, which element replaces NAKs?
A. Checksums
B. Duplicate ACKs
C. Timeouts
D. Sequence bits
Answer: B
9. The **transport-layer checksum** detects:
A. Header corruption only
B. Data and header errors end-to-end
C. Bit errors per hop
D. Missing fragments
Answer: B

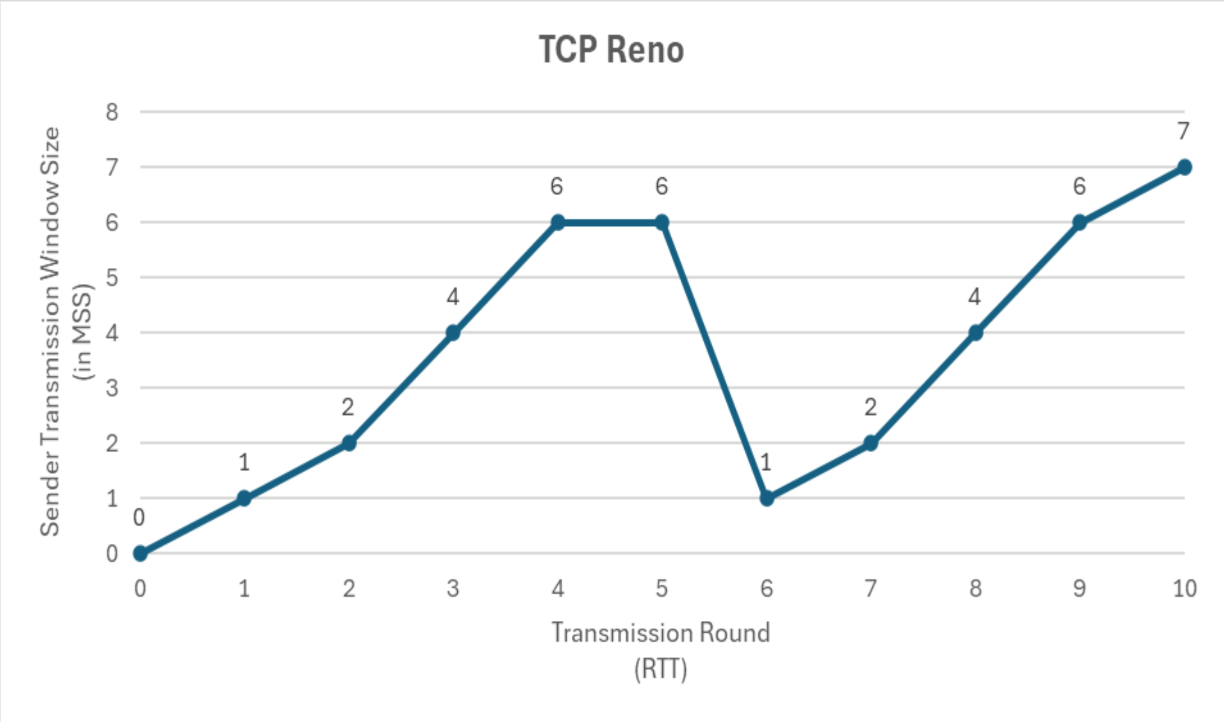
Q2: **by Dr. Ahmad Raza** Sec. 3.3 & 3.4

Question 2 Solution:

Q3: Consider a TCP Reno connection as illustrated by the graph below. Please also note the points below:
- 1 MSS = 100 bytes, 1 RTT = 150 msec
- 184^{th} segment sent by the sender is lost,
- At RTT = 0, TCP connection has been established but no segment has been sent by the sender yet. Initial (default) values of different parameters at RTT = 0 are given in the table below. (The sender starts it's transmission, i.e. sends the first segment at RTT = 1.)
- Out of sequence received segments are not buffered but discarded

- SS is short for Slow Start, CA for Congestion Avoidance, FR for Fast Recovery & N/A for Not Applicable.

Please copy the table given for the TCP sender in the answer sheet & fill out the missing values in the table in the answer sheet. (Filled entries in the table in the question paper will not be marked.) **[15 Marks]**



TXN Round (RTT)	Time (ms)	Receive Window (rwnd in MSS)	Congestion Window (cwnd in MSS)	Slow Start Threshold (ssthresh in MSS)	Received ACK Number	Sequence Number of Transmitted Segment(s)	Timer (Timeout in ms)	No Loss Or Timeout Or 3dupAck	TCP Sender Mode (SS or CA or FR)
0	0	6	0	12	N/A	N/A	600	No Loss	N/A
1		6			N/A		600	No Loss	SS
2	300	6		12			600	No Loss	SS
4			8	12			600	No Loss	
5				12	1300		600	No Loss	
6	900	20							
10		20		6			1200		

Q3 Solution:

TXN Round (RTT)	Time (ms)	Receive Window (rwnd in MSS)	Congestion Window (cwnd in MSS)	Slow Start Threshold (ssthresh in MSS)	Received ACK Number	Sequence Number of Transmitted Segment(s)	Timer (Timeout in ms)	No Loss Or Timeout Or 3dupAck	TCP Sender Mode (SS or CA or FR)
0	0	6	0	12	N/A	N/A	600	No Loss	N/A
1	150	6	1	12	N/A	0	600	No Loss	SS
2	300	6	2	12	100	100, 200	600	No Loss	SS
4	600	6	8	12	700	700, 800, 900, 1000, 1100, 1200	600	No Loss	SS
5	750	6	6 MSS or 12 MSS or 14 MSS	12	1300	1300, 1400, 1500, 1600, 1700, 1800	600	No Loss	SS
6	900	20	1	6	1700	1700	1200	Time Out	SS
10	1500	20	7	6	3000	3000, 3100, 3200, 3300, 3400, 3500, 3600	1200	No Loss	CA

Lost segment

CLO 2 (): Demonstrate **the basics of network concepts using state-of-the-art network tools/techniques**. **[Marks]**

Q4: [14 Marks] by Dr. Abdul Qadeer Sec 4.1 & 4.3 (excluding IPv4 subnetting)

Host A sends a single IPv4 datagram to *Host B* over the Internet. There is a single network path from A to B with two intermediate routers (*R1* and *R2*). Original datagram exiting *Host A* has following values in its IPv4 header:

Total Length (Bytes)	IP Header Length (Bytes)	Identification (ID) (Hexadecimal)	DF Flag	MF Flag	Fragment Offset
4000	20	0xCAFE	0	0	0

Note that no IP options are used. Recall that *fragment offset* field is 13 bits wide in IPv4 header.

Maximum Transmission Unit (MTU) on the link connecting Host A to Router R1 is 9000 Bytes.
MTU on the link connecting router R1 to router R2 is 1500 Bytes.
MTU on the link connecting router R2 to the destination Host B = 512 Bytes.

(a) On your answer sheet, draw a 6-column table (like the example above) and fill in the details for every fragment created by router R1.

(b) On your answer sheet, draw the same 6-column table. Use it to list all sub-fragments (if any) created by router R2 as it processes the packet(s) from R1.

Q4 Solution:

Router R1 decides after consulting its forwarding table that the original datagram needs to go to router R2. But the link from R1 to R2 has MTU of 1500 Bytes while the original datagram is of size 4000 Bytes. Router looks at the DF flag (whose value is 0) to verify that it is allowed to do IPv4 datagram fragmentation.

Payload size = 4000 – 20 = 3980 Bytes
First fragment will have = 20 Bytes header + 1480 Bytes of payload
Second fragment will have = 20 Byte IPv4 header + 1480 Bytes of payload
Third fragment will have = 20 Bytes + remaining 1020 Bytes

(Recall that fragment offset count blocks of 8 Bytes)

Total Length (Bytes)	IP Header Length (Bytes)	Identification (ID) (Hexadecimal)	DF Flag	MF Flag	Fragment Offset
1500	20	0xCAFE	0	1	0
1500	20	0xCAFE	0	1	185
1040	20	0xCAFE	0	0	370

Since there is a single path from R1 to R2, no packet re-ordering will happen and above fragment will arrive in order at router R2.

MTU from R2 to Host B = 512 Bytes
512 – 20 = 492 Bytes payload possible
But 8 does not evenly divide 492 (Offset counts in blocks of 8 Bytes)
So, we can send max payload of size 488 Bytes in each datagram from R2 to B.

Total Length (Bytes)	IP Header Length (Bytes)	Identification (ID) (Hexadecimal)	DF Flag	MF Flag	Fragment Offset
508	20	0xCAFE	0	1	0
508	20	0xCAFE	0	1	61
508	20	0xCAFE	0	1	122
36	20	0xCAFE	0	1	183

Same for second fragment coming from R1:

Total Length (Bytes)	IP Header Length (Bytes)	Identification (ID) (Hexadecimal)	DF Flag	MF Flag	Fragment Offset
508	20	0xCAFE	0	1	185
508	20	0xCAFE	0	1	246

508	20	0xCAFE	0	1	307
36	20	0xCAFE	0	1	368

And for the third fragment:

Total Length (Bytes)	IP Header Length (Bytes)	Identification (ID) (Hexadecimal)	DF Flag	MF Flag	Fragment Offset
508	20	0xCAFE	0	1	370
508	20	0xCAFE	0	1	431
64	20	0xCAFE	0	0	492

Suggested Rubric:

(1) Total 14 rows across all tables. 1 Mark for each row.
(2) In each row:
   a. 0.25 marks for correct Total Lenth
   b. 0.25 marks for correct MF flag
   c. 0.25 marks for correct Fragment offset
   d. 0.25 marks collectively for (IP header length, ID, DF flag)
(3) Marks become [3+11] (3 rows needed for part a and 11 for part b)
   a. Part-wise distribution not mentioned on question paper to avoid giving students unwanted clues about answer

Question 4 Solution:

Q5: Sir Umar Bin Farooq Sec 4.4 & 4.5

Question 5 Solution

Q6: By Umm-e-Ammarah Sec .3.1 & 3.2

Question 6 Solution

Q7: You are given the network 192.168.50.0/24 for an organization with the following subnet requirements:
- CS Department requires 100 hosts.
- IT Department requires 62 hosts.
- Finance Department requires 50 hosts.
- Admin office requires 20 hosts.
- Director office requires 10 hosts.

Your task is to allocate addresses optimally performing VLSM as per the given requirements and determine the following for each subnet: **[2.5 x 5 + 1.5 = 14 Marks]**
(i) Prefix / Subnet Mask (ii) Network Address (iii) First Usable Host Address

(iv) Last Usable Host Address (v) Broadcast Address

Moreover, kindly find the leftover / free addresses inside /22 after fulfilling the above requirement optimally.

Q 7 Solution

Department /Office	Subnet Mask	Network Address	First Usable Host Address	Last Usable Host Address	Broadcast Address
HR	255.255.255.128	19.168.48.0	192.168.48.1	192.168.48.126	192.168.48.127
IT	255.255.255.192	19.168.48.128	192.168.48.129	192.168.48.190	192.168.48.191
Finance	255.255.255.192	19.168.48.192	192.168.48.193	192.168.48.254	192.168.48.255
Admin	255.255.255.224	19.168.49.0	192.168.49.1	192.168.49.30	192.168.49.31
Director	255.255.255.240	19.168.49.32	192.168.49.33	192.168.49.46	192.168.49.47

Used address space up through 192.168.49.47

Remaining free addresses inside the /22 address space: 192.168.49.48 to 192.168.51.255
Which means 720 addresses are still left) i.e.,208+256+256 = 720 are left while 304 are addresses are allocated.