# Computer Networks Fall 2025

Assignment#3 (5A & 5C)

**Due Date: Thursday, 9th October, 2025**

**Submission Mode & Time:** Handwritten solutions to be submitted during the lecture.

**Please note the following:**

1. No exceptions to the above date and time will be allowed. Inability to submit the assignment by the required time will result in zero marks.

2. To ensure self-completion of assignments and discourage plagiarism, the instructor or the relevant TA may randomly contact you and ask for an explanation of your answers. Where plagiarism and/or cheating is evident, you will be referred to the departmental disciplinary committee. In extreme cases of plagiarism an F may be awarded immediately with further referral to the university disciplinary committee.

3. All solutions must be **hand-written.**

4. **Assignment Solution Submission**: In case of **in person / physical lectures at the campus**, hard copy of the hand-written assignment's solutions will be submitted by **hand** by each student to the Instructor / TA directly during the lecture on the due date.

## PART-1

**Use the following text for completion of this part of the assignment:**
**Computer Networking - A Top-Down Approach 8th Edition by Kurose & Ross.**

Solve the following problems from the back of **Chapter 3**. Every Question has equal marks i.e.

**Review Questions: (3*1 = 3 marks)** **[CLO 3]**

R3

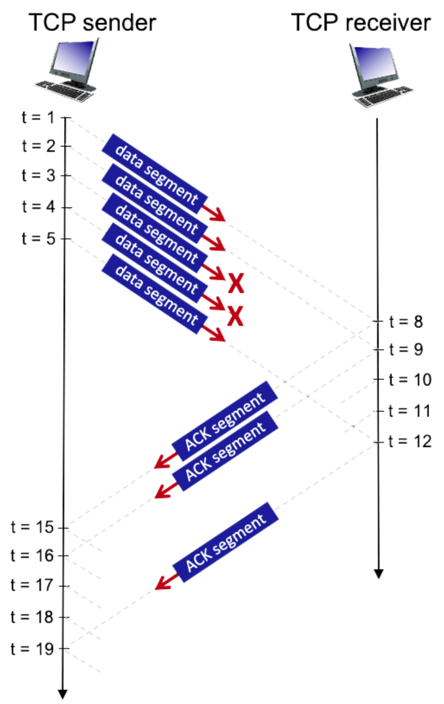
**Problems: (3*5 = 15 marks)** **[CLO 3]**

P2, P3, P4, P26, P40

# PART - 2

**<u>Question: 01 [1*15 = 15 Marks]</u>** **[CLO 3]**

Consider the figure below in which a TCP sender and receiver communicate over a connection in which the segments can be lost. The TCP sender wants to send a total of 10 segments to the receiver and sends an initial window of 5 segments at t = 1, 2, 3, 4, and 5, respectively. Suppose the initial value of the sequence number is 161 and every segment sent to the receiver each contains 853 bytes. The delay between the sender and receiver is 7 time units, and so the first segment arrives at the receiver at t = 8, and an ACK for this segment arrives at t = 15. As shown in the figure, 2 of the 5 segments are lost between the sender and the receiver, but none of the ACKs are lost. Assume there are no timeouts and any out of order segments received are thrown out.

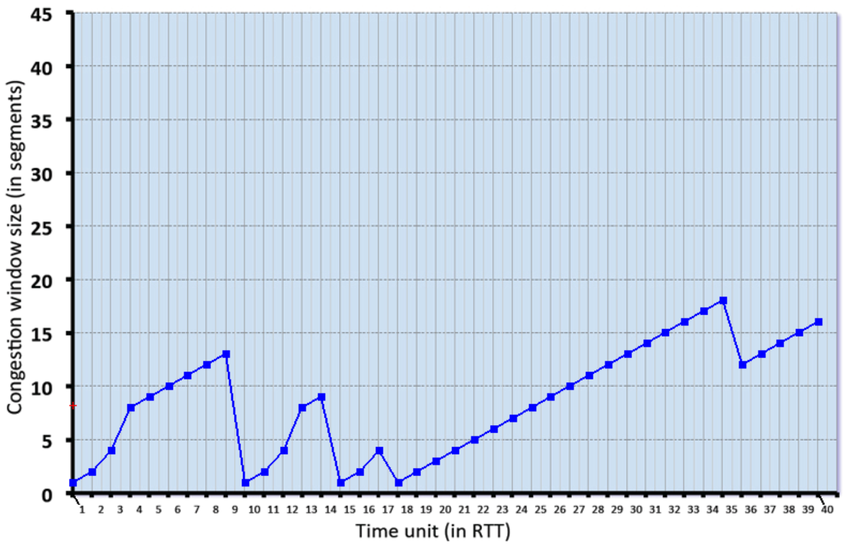



(1) What is the Sequence Number of the Segment sent at t = 1?
(2) What is the Sequence Number of the Segment sent at t = 2?
(3) What is the Sequence Number of the Segment sent at t = 3?
(4) What is the Sequence Number of the Segment sent at t = 4?
(5) What is the Sequence Number of the Segment sent at t = 5?
(6) What is the value of the ACK sent at t=8? (If segment lost, write 'x')
(7) What is the value of the ACK sent at t=9? (If segment lost, write 'x')
(8) What is the value of the ACK sent at t=10? (If segment lost, write 'x')
(9) What is the value of the ACK sent at t=11? (If segment lost, write 'x')
(10) What is the value of the ACK sent at t=12? (If segment lost, write 'x')
(11) What is the sequence number of the segment sent at t = 15? (If ACK never arrives, write 'x')
(12) What is the sequence number of the segment sent at t = 16? (If ACK never arrives, write 'x')
(13) What is the sequence number of the segment sent at t = 17? (If ACK never arrives, write 'x')

(14) What is the sequence number of the segment sent at t = 18? (If ACK never arrives, write 'x')

(15) What is the sequence number of the segment sent at t = 19? (If ACK never arrives, write 'x')

## Question: 02 [6 * 2 = 12 Marks] [CLO 3]




Consider the figure above, which plots the evolution of TCP's congestion window at the beginning of each time unit (where the unit of time is equal to the RTT); see Figure 3.53 in the text. In the abstract model for this problem, TCP sends a "flight" of packets of size cwnd at the beginning of each time unit. The result of sending that flight of packets is that either (i) all packets are ACKed at the end of the time unit, (ii) there is a timeout for the first packet, or (iii) there is a triple duplicate ACK for the first packet. In this problem, you are asked to reconstruct the sequence of events (ACKs, losses) that resulted in the evolution of TCP's cwnd shown. Consider the evolution of TCP's congestion window in the example above and answer the following questions. The initial value of cwnd is 1 and the initial value of ssthresh (shown as a red +) is 8:

(1) Give the times at which TCP is in slow start.
(2) Give the times at which TCP is in congestion avoidance.
(3) Give the times at which TCP is in fast recovery.
(4) Give the times at which packets are lost via timeout.
(5) Give the times at which packets are lost via triple ACK.
(6) Give the times at which the value of ssthresh changes (if it changes between t=3 and t=4, use t=4 in your answer).

## Question: 03 [3 * 2 = 6 Marks] [CLO 3]

Consider a TCP connection where the Maximum Transmission Unit (MTU) is 1,500 bytes, the round-trip time (RTT) is 100 ms, and no packet losses occur. (a) If the connection is in steady state, with no losses, what is the average throughput of the connection? Assume that the congestion window size is 10 MTU. (b) If a single packet loss occurs, estimate how the throughput would be affected in the next RTT. Assume fast retransmit and fast recovery are used. (c) How does TCP throughput behave when the RTT increases, assuming no other changes?

## **Question: 04 [4 Marks]** **[CLO 3]**

Suppose a sender is transmitting packets over a lossy channel using a Stop-and-Wait protocol. If the probability of packet loss (either the data packet or the acknowledgment) is 0.2, what is the probability that a single packet will be successfully transmitted and acknowledged without requiring retransmission?

## **Question: 05 [3 Marks]** **[CLO 3]**

A network engineer is monitoring a TCP connection between a client and a remote server. To ensure smooth data transfer, TCP adjusts its timeout interval based on real-time network conditions. At the moment, TCP's Estimated RTT is 210 milliseconds, and the Deviation in RTT (Dev RTT) is 49 milliseconds. As new data packets are transmitted, the engineer records two new RTT measurements: 280 ms and 210 ms. Since TCP dynamically updates its timeout values to adapt to changing network conditions, the engineer needs to recalculate the following after each new RTT measurement:

1. The updated Estimated RTT
2. The updated Deviation RTT (Dev RTT)
3. The new TCP Timeout Interval

Using $\alpha = 0.125$ and $\beta = 0.25$, determine how these values change after each measurement. Consider how these adjustments impact the connection's reliability and responsiveness.