Q1: MCQs: Fill the following table by choosing the correct options from given MCQs. [20 marks]

1	a	2		3	a	4	c
5	b	6	c	7	a	8	c
9	c	10	a	11		12	d correct
13	c	14	c	15	b	16	a
17		18		19	c	20	

1. A packet of 2000 bytes is sent over a link with a bandwidth of 1 Mbps (1×10^6 bps). The propagation speed is 2×10^8 m/s, and the distance between sender and receiver is 1000 km. The processing delay is 1 ms, and there is no queuing delay. What is the total delay?
   a. 22
   b. 17
   c. 25
   d. 30
2. In stop and wait protocol_____
   a. Ack number is required.
   b. Sequence numbers are not required.
   c. Sequence numbers are required.
   d. Next expected sequence number is required.

3. _____ control refers to a set of procedures used to restrict the amount of data that the sender can send before waiting for acknowledgment.
   a. Flow
   b. Error
   c. Transmission
   d. Data
4. In case of rdt2.2 receiver can send _____ reply to sender.
   a. Only NAK
   b. Both ACK and NAK
   c. Only ACK
   d. None of the above
5. Size of source and destination port address of TCP header respectively are _____
   a. 16-bits and 32-bits
   b. 16-bits and 16-bits
   c. 32-bits and 16-bits
   d. 32-bits and 32-bits
6. A Process A had 100 bytes' space available in both its SendBuffer and the RecvBuffer. It then receives 20 bytes data from Process B and in the TCP segment received, the window size is mentioned as 200 bytes. What would be the window size Process A would put in the next segment it sends to Process B?
   a. 180
   b. 220
   c. 80
   d. 120
7. What is the three-way handshake sequence used to initiate TCP connections?
   a. SYN, SYN/ACK, ACK
   b. ACK, SYN/ACK, ACK
   c. SYN, SYN, ACK/ACK
   d. ACK, SYN/ACK, SYN
8. What is the relation between MSS and MTU?
   a. The minimum amount of application layer data in a segment is called MSS

b. The maximum amount of application layer data in a segment plus the size of TCP should not exceed maximum transmission unit (MTU)
c. The maximum amount of application layer data in a segment plus the size of TCP/IP header should not exceed maximum transmission unit (MTU)
d. None of the above

9. TCP assigns a sequence number to each packet (called segment) that is being sent. The sequence number for a segment sent after a segment having n as sequence number would be:
   a. n+1
   b. n+MTU
   c. n+MSS
   d. None of the above
10. In rdt 3.0 a packet is retransmitted if:
   a. Timeout event occur
   b. Packet is corrupted
   c. both a) and b)
   d. None of the above
11. Consider an instance of TCP's Additive Increase Multiplicative Decrease (AIMD) algorithm where the window size at the start of the slow start phase is 2 MSS and the threshold at the start of the first transmission is 8 MSS. Assume that a timeout occurs during the fifth transmission. Find the congestion window size at the end of the tenth transmission.
   a. 8 MSS
   b. 14 MSS
   c. 7 MSS
   d. 12 MSS
12. Let the size of congestion window of a TCP connection be 32 KB when a timeout occurs. The round trip time of the connection is 100 msec and the maximum segment size used is 2 KB. The time taken (in msec) by the TCP connection to get back to 32 KB congestion window is _____.
   a. 900
   b. 1000

c. 1100

d. 1200

13. Suppose TCP Tahoe is used instead of TCP Reno, and assume that triple duplicate ACKS are received at the 16th round where the cwnd value is 32 KB. What are the ssthresh and the congestion window size?

a. CWND=1kb, Threshold-32 kb

b. CWND=0kb, Threshold 16 kb

c. CWND=1kb, Threshold 16 kb

d. CWND=16kb, Threshold 16 kb

14. In relation to TCP Flow Control, which of the following statements is true?

a. The receive window at Receiver is set to the amount of spare room in the buffer: rwnd = RevBuffer - [LastByteRead - LastByteRcvd]

b. For flow control, the Sender keeps the amount of unacknowledged data greater than the value of rwnd, i.e. LastByteSent - LastByteAcked <= rwnd

c. The receive window at Receiver is set to the amount of spare room in the buffer: rwnd = RevBuffer - [LastByteRcvd - LastByteRead]

d. None of the above

15. What are the similarities between TCP and UDP sockets?

a. Both require MAC addresses for de-multiplexing.

b. Both require some port number for de-multiplexing.

c. Both require some IP address for de-multiplexing.

d. All of the above

16. The packet sent by a node to the source to inform it of congestion is called _____

a. Choke

b. Explicit

c. Discard

d. Backpressure

17. In Go-Back-N, if frames 4, 5, and 6 are received successfully, the receiver may send an ACK _____ to the sender.

a. 5

b. 6

c. 7

d. 4

18. The size of the TCP advertised window (RevWindow) never changes throughout the duration of the connection

a. It is the size of the receiver's buffer that's never changed

b. RevWindow is the part of the receiver's buffer that's changing all the time

c. Both (a) and (b)

d. Advertised window (Rev Window) never changes

19. In the _____ protocol we avoid unnecessary transmission by sending only frames that are corrupted.

a. Stop-and-Wait

b. Go-Back-N

c. Selective-Repeat

d. None of the above

20. _____ control refers to a set of procedures used to restrict the amount of data that the sender can send before waiting for acknowledgment.

a. Flow

b. Congestion

c. Transmission

d. None of the above

Question #2. **Marks: 5*3=15**

A company is using a Go-Back-N protocol for packet transmission. A sender wants to transmit 10 packets to a receiver with a window size of 4. Due to network congestion, Packet 3 and Packet 6 get lost during transmission.

Part A

Illustrate the flow of packets from the sender to the receiver, including:

- The initial packet sequence being sent.
- How the sender handles the lost packets.
- How the receiver acknowledges packets.

- The retransmission process.

Part B

A sender measures the following **SampleRTT** values (in milliseconds) for four packets:

Packet 1: 100 ms

Packet 2: 120 ms

Packet 3: 110 ms

Packet 4: 130 ms

The initial **EstimatedRTT** is **100 ms**, and the smoothing factor **α = 0.125**. The **β value** for deviation calculation is **0.25**.

Find the Timeout Interval using the formula:

$$\text{TimeoutInterval} = \text{EstimatedRTT} + 4 \times \text{DevRTT}$$

Question #3. **Marks: 5*3=15**

A TCP sender transmits a 10 MB file using TCP Reno or TCP Tahoe. The initial cwnd = 1 MSS (1,000 bytes), ssthresh = 16 MSS, and RTT = 50 ms. Packet losses are detected via three duplicate ACKs or a timeout (250 ms).

a. Calculate the number of RTTs needed for cwnd to grow from 1 MSS to 32 MSS in TCP Reno and TCP Tahoe. Identify when slow start ends.
b. Compute the total bytes transmitted before cwnd reaches 32 MSS.
c. If a packet is lost at cwnd = 32 MSS and the sender receives three duplicate ACKs, determine the new values of cwnd and ssthresh for both TCP Reno and TCP Tahoe.
d. If a packet loss at cwnd = 32 MSS is detected through a timeout, determine the new values of cwnd and ssthresh and compare the recovery times of TCP Reno and TCP Tahoe.
e. If losses occur whenever cwnd reaches 16, 32, 64, etc., determine which algorithm achieves higher long-term throughput. Estimate the time to transfer 10 MB for both TCP Reno and TCP Tahoe.