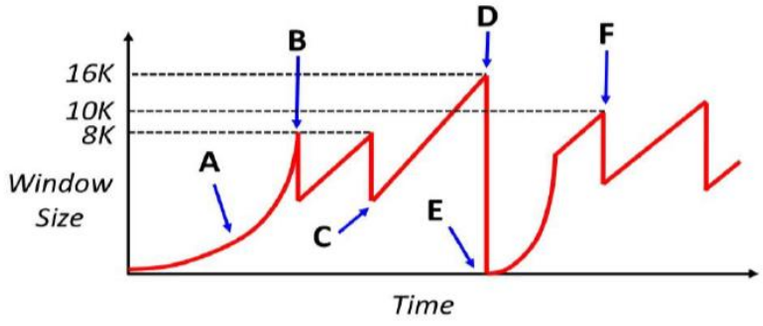
## QUESTION 1 (SELECT THE BEST ANSWER TO THE FOLLOWING SUB-QUESTIONS.) – (30%)

| | ANSWER |
|---|---|
| 1. Which is the transport layer protocol used by Email service?<br>(a) TCP<br>(b) PoP3<br>(c) HTTP<br>(d) UDP | a |
| 2. Which of the following is a multiplexing method used in the circuit switch network?<br>(a) Statistical multiplexing<br>(b) Random multiplexing<br>(c) Time division multiplexing<br>(d) None of the above | c |
| 3. How many number of unACKed packet is allowed for the stop-and-wait protocol?<br>(a) 1<br>(b) 2<br>(c) 4<br>(d) 8 | a |
| 4. Given an IP address 155.127.110.89 with subnet mask /16, which is the network address of this subnet?<br>(a) 155.127.110.68<br>(b) 155.127.110.0<br>(c) 155.127.0.0<br>(d) None of the above | c |
| 5. Which one is NOT the feature of peer-to-peer communication model?<br>(a) Exist a central server<br>(b) Each host runs program that performs both client and server function<br>(c) No single point of failure<br>(d) Peers can directly communicate with each other | a |
| 6. The original data unit is 1 0 0 1 0 0 1. When odd parity checking scheme is used, the parity bit should be _____.<br>(a) 0<br>(b) 1<br>(c) Both 0 and 1<br>(d) None of the above | a |
| 7. Which of the following address describes a broadcast address?<br>(a) All network bits are 0s<br>(b) All network bits are 1s<br>(c) All host bits are 0s<br>(d) All host bits are 1s | d |
| 8. In go-back-N ARQ, suppose the number of bits used to identify the sequence number of packet is m=4. The maximum sender window size N is _____.<br>(a) 2<br>(b) 4<br>(c) 15<br>(d) None of the above | c |

9. The event at point B in the following figure causes the sender to decrease the transmission window. This event is named as _____.

a




(a) 3 Duplicate ACK
(b) Slow Start
(c) Time Out
(d) None of the above

10. Which of the following is the length of IPv4 address in bits?
(a) 1
(b) 32
(c) 48
(d) 64

b

11. Which of the following is the responsibilities of the network layer?
(a) Framing
(b) MAC addressing Link
(c) Access control
(d) Routing

D

12. HTTP is a "stateless" protocol. Which of the following is a way to address its disadvantage by keeping track of users' history?
(a) Cookies
(b) Key
(c) SMTP
(d) UDP

a

13. In a class C IP address, how many bits are for the subnet part?
(a) 4
(b) 8
(c) 16
(d) 32

b

二、五类传统 IP 地址（Classful Addressing）

| 类别 | 地址范围（第1字节） | 网络位数 | 主机位数 | 默认子网掩码 | 用途 |
|---|---|---|---|---|---|
| A 类 | 1 – 126 | 8 | 24 | 255.0.0.0 (/8) | 大型网络 |
| B 类 | 128 – 191 | 16 | 16 | 255.255.0.0 (/16) | 中型网络 |
| C 类 | 192 – 223 | 24 | 8 | 255.255.255.0 (/24) | 小型网络 |
| D 类 | 224 – 239 | - | - | - | 多播（Multicast） |
| E 类 | 240 – 255 | - | - | - | 保留研究使用 |

14. Which of the following is not a Transport Layer protocol?
(a) TCP
(b) UDP
(c) HTTP Application.
(d) None of the above

C

15. The main purpose of domain name system (DNS) service is _____.
(a) to provide reliable transmission
(b) to provide secure transmission
(c) to provide transformation between the hostname and IP address
(d) to reduce error in transmission

C

**QUESTION 2.** (10 points) Suppose two nodes A and B are separated by 500 km and connected by a direct link with the data rate of 1000 Mbps. Suppose the propagation speed over the link is $2.5 * 10^8$ meters/second.

(2.1) Please calculate the propagation delay from A to B.
(2.2) Consider sending a file of 100M bits from A to B. Suppose the file is sent continuously as one large message. Please calculate the transmission delay of this file.

2.1: $D_{pro} = \frac{500000\,m}{2.5\times10^8\,m/s} = 0.002\,s$

2.2: $D_{trans} = \frac{100\,M\,bits}{100\,M\,bps} = 0.1\,s$

**Question 3.** (10 points) Suppose N packets arrive at the buffer of sending node simultaneously. They are the same packet size of L= 1500 bytes and the transmission rate is R=10Mbps. We assume that the output link is exclusively used by these arrival packets and the first packet has no queueing delay.

(3.1) Please calculate the queueing delay of the 2nd packet and the 3rd packet, respectively. (6 points)

$D_{que2^{nd}} = 1\times\frac{L}{R} = \frac{1500\times8\,bits}{10\,000000\,bps} = 0.0012\,s$

$D_{que3^{rd}} = 2\times\frac{L}{R} = 0.0024\,s$

(3.2) Let N=5. Please derive the average queueing delay of these 5 packets. (4 points)

$D_{Total} = (1+2+3+4)\times\frac{L}{R} = 0.012\,s$

$D_{average} = \frac{D_{Total}}{5} = 0.0024\,s$

**Question 4.** (10 points) A channel has transmission rate of 100 Mbps and one way propagation delay of 9 msec. We assume that the transmission delay of ACK is not considered.

(4.1) Given that the stop and wait is used to provide the reliable transmission over the channel, Please calculate the minimum packet size in order to get a channel efficiency of at least 10%

(4.2)Given that Go-back-N is used to provide the reliable transmission over the channel, and the size of each packet is 120000 bits. (a) Calculate the transmission delay of each packet. (b) We assume that no error during the transmission. Let N=5, please calculate the channel utilization. (c) In order to achieve the channel utilization of 62.5%, please derive the value of window size N.



$\frac{L}{100\times10^6\,bps}$

(4.1) $10\% = 9\times10^{-3}\times2 + \frac{L}{100\times10^{6}\ bps}$

$L = 200000\ bits$

(4.2) (a) $D_{tran} = \frac{120000\ bits}{100000000\ bps} = 0.00125 = 1.2ms$

(b) $U = \frac{N \cdot D_{tran}}{D_{tran} + D_{pro}} = \frac{5\times 1.2ms}{1.2ms + 9ms} \approx 58.8\%$

(c) $62.5\% = \frac{N' \times D_{tran}}{D_{tran} + D_{pro}} = \frac{N'\times 1.2\ ms}{(1.2+9)\ ms}$

$N' \approx 5.3$ so $N' \to 6$

**Question 5.** (10 points) TCP can provide both the flow control and congestion control.

(5.1) Explain the reason and the objective of doing the flowing control.

Flow control prevents sender overflow at the receiver and keeps data transfer reliable by matching the sender's rate to the receiver's capacity.

(5.2) Explain the reason and objective of doing the congestion control.

Congestion control prevents network overload by controlling the sender's rate, keeping the network efficient and avoiding packet loss.

**Question 6**. (10 points) How to estimate round trip time (RTT) and how to set the time of timeout are very important in the TCP protocol.

(6.1) Explain the drawback if the time of timeout is set as too long or too short. (2 points)

Too short → unnecessary retransmissions.
Too long → slow error recovery.

(6.2) Exponential weighted moving average (i.e., EstimatedRTT = (1- α)*EstimatedRTT + α*SampleRTT ) is usually used to estimate the average RTT. Explain the features of this method. (2 points)

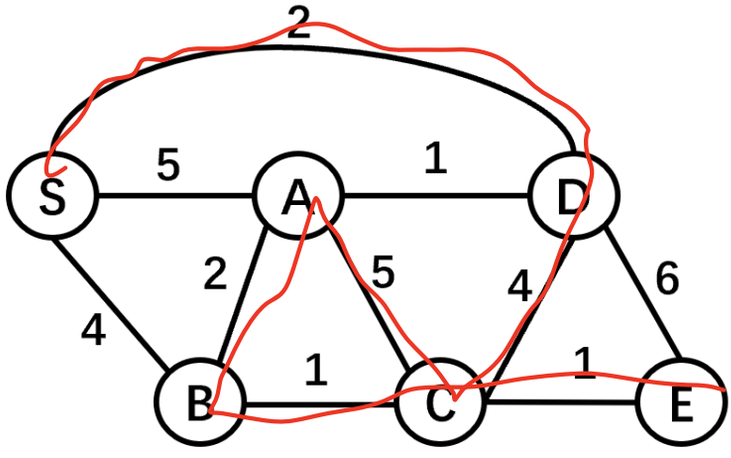
reacts to new samples gradually, avoiding large variations due to temporary network delay.

(6.3) Please use the exponential moving average to calculate the estimated RTT and fill in the following table, where we assume α=0.1. Note that calculation is done in full precision and the results are shown only to the nearest integer. (6 points)

| Pkt # | SampleRTT (ms) | Estimated RTT (ms) |
|---|---|---|
| 1 | 100 | 100 |
| 2 | 80 | |
| 3 | 90 | |
| 4 | 400 | |

**Question 7.** (10 points) A weighted undirected graph G and the cost of each edge are given as follows.

(7.1) Please use **Dijkstra's algorithm** to find the shortest path from the source **node S** to any other nodes and fill the result of each iteration into the following table, where *T* is the set of nodes whose least cost path are known. D(x) and path are the least cost and corresponding path from the source node S to the node x, respectively. (8 points)

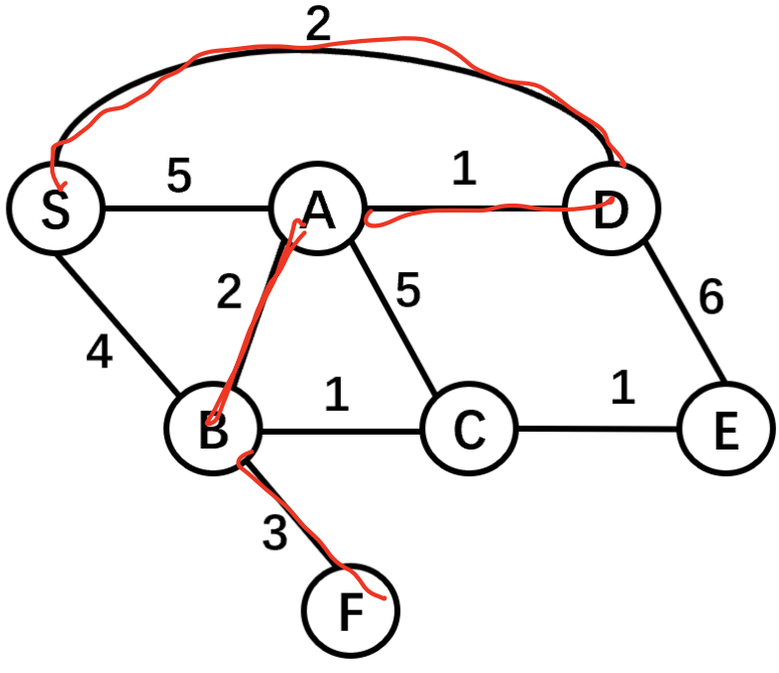


| Iteration Index | T | D(A) and path | D(B) and path | D(C) and path | D(D) and path | D(E) and path |
|---|---|---|---|---|---|---|
| 1 | {S} | 5<br>S-A | 4<br>S-B | ∞<br>- | **2**<br>**S-D** | ∞<br>- |
| 2 | {S, D} | **3**<br>**S-D-A** | 4<br>S-B | 6<br>S-D-C | **2**<br>**S-D** | 8<br>S-D-E |
| 3 | | | | | | |
| 4 | | | | | | |
| 5 | | | | | | |
| 6 | | | | | | |

(7.2) Please fill in the forwarding table at node A as follows. (2 points)

| **Destination node** | **Output link** |
|---|---|
| **A** | S-D |
| **B** | |
| **C** | |
| **D** | |
| **E** | |

**Question 8.** (10 points) A connected weighted undirected graph G and the cost of each edge are given as follows. Please use the **Prim's algorithm** to construct the minimum spanning tree of G with starting from **the node S**.



(8.1) Please fill the following table where T denotes the set of nodes whose minimum weighted edge have already known at the corresponding iteration. (5 points)

| Iteration index | T |
|---|---|
| 1 | {S} |
| 2 | {S, D} |
| 3 | |
| 4 | |
| 5 | |
| 6 | |
| 7 | |

(8.2) Draw the derived minimum spanning tree. (5 points)