Section I. Multiple Choice Questions (MCQs)

Each MCQ has one correct answer. There is no penalty for wrong answers.

1. Which of the following statements about client/server paradigm is TRUE?

    A. Client must always be alive. ✗
    B. Server offers service while client requests for service from server. ✓
    C. Only server can transmit data to client. ✗
    D. Only client can transmit data to server. ✗
    E. Server must run either DNS or HTTP protocol. ✗

    B.

2. Which of the following is the most appropriate description of the service provided by UDP? → Transport layer, runs in hosts.

    noter.

    A. Process-to-process communication
    B. Host-to-host communication
    C. End-to-end reliable data delivery ✗
    D. Guarantee on minimal throughput and timing ✗
    E. Connection-oriented multiplexing and de-multiplexing

    B   A

3. Which of the following statements regarding the Internet is TRUE?

    A. A call setup is always performed before data transmission starts. ?
    B. The Internet is structured as a network of networks. ✓
    C. A packet passes through no more than two autonomous systems to reach destination host. ✗
    D. The only access network technologies allowed are Ethernet and Wi-Fi. ✗
    E. None of the rest

    B ✓

4. A UDP server needs only one socket to communicate with *n* different clients. How many sockets would a TCP server have ever created for the same situation?

    A. 1
    B. *n*
    C. *n+1*
    D. 2*n*
    E. None of the rest

    C. ✓

5. In a client/server connection using HTTP over TCP, if multiple objects are sent over the same TCP connection, then this connection is classified as _____.

    A. stateless
    B. stateful
    C. conditional
    D. persistent
    E. non-persistent

    D. ✓

6. Consider sending a sequence of packets from a host in NUS to another host in NTU. Suppose packets may be of different length but all go through the same route to the destination. Which of the following end-to-end delay component is a constant (i.e. doesn't vary from packet to packet)?

    A. Queueing delay ✗
    B. Transmission delay
    C. Propagation delay ⌣
    D. Processing delay
    E. None of the rest

    C. ✓

7. Which of the following statements is TRUE when a packet containing application message is passed from router A to router B in the Internet?

    A. Upon arrival, the packet may be discarded by B if B's buffer is full. ✓
    B. A and B must establish a TCP connection before the packet is transmitted. ?
    C. A may pass the packet to B through a UDP connection. ?
    D. Circuit must be reserved before A can pass the packet to B. ✗
    E. None of the rest

    A. ✓

8. Which of the following statements regarding TCP is TRUE?

    A. If a TCP segment has sequence number m, then ACK for this segment will have acknowledgement number m.   ✗
    B. If a TCP segment has sequence number m, then ACK for this segment will have acknowledgement number $m + 1$. ✓ → not necessarily. → $m + size + 1$.
    C. Host A is sending a file to host B over a TCP connection. If B has no data to send to A, B will not send ACK packets because B cannot piggyback the acknowledgments on data.   ?
    D. TCP doesn't function correctly in a network that may re-order packets. ✗
    E. None of the rest

    B. ~C~

    A ⟶ B.
    ⟵
    ACK.

9. Which of the following is a VALID subnet mask?

A. 255.250.255.0

B. 255.255.208.0

C. 255.240.0.0

D. 255.232.0.0

E. 127.0.0.0

10. In rdt3.0, what does the sender do if it receives a duplicate ACK and what does the receiver do if it receives a duplicate packet?

A. Sender does nothing; receiver does nothing.

B. Sender does nothing; receiver sends ACK for the previous packet.

C. Sender resends data packet; receiver does nothing.

D. Sender resends data packet; receiver sends ACK for the previous packet.

E. None of the rest
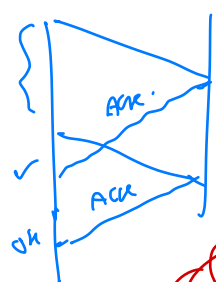
11. GBN sender has _____ timer(s), SR sender has _____ timer(s) and TCP sender has _____ timer(s).

A. One; multiple; one

B. One; multiple; multiple

C. One; one; one

D. Multiple; multiple; multiple

E. None of the rest

12. In GBN, ACK m means _____.

A. Receiver has received all the packets up to packet m.

B. Receiver has received all the packets up to packet m-1.

C. Receiver has received packet m. But there is no implication on the receipt of other packets.

D. The next in-order packet expected by receiver is packet m.

E. None of the rest

13. Which of the following statements about TCP initial sequence number (ISN) is TRUE, given that sequence number field in TCP header is 32 bits?

A. ISN is increased by 1 after sending every TCP segment.

B. In bi-directional communication, both directions of communication must choose different ISNs.

C. ISN determines the amount of data that can be transmitted over TCP.

D. ISN is randomly chosen between [0, $2^{32}-1$], both inclusive.

E. None of the rest

%*

$ }

@

?

?

?

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CS2105

14. **Telnet** protocol allows a user to establish a TCP connection to a remote server. Consider the following command.

```
telnet www.nus.edu.sg 80
```

Which of the following statement is TRUE?

i. The command causes a DNS lookup for the IP address of **www.nus.edu.sg**.
ii. The command causes a TCP SYN packet to be sent to **www.nus.edu.sg**.
iii. The command causes a HTTP request to be sent to **www.nus.edu.sg**.
iv. The command causes host **www.nus.edu.sg** to open port 80 and listen for incoming connections.

A. (i) only
B. (i) and (ii) only
C. (i), (ii) and (iv) only
D. (ii), (iii) and (iv) only
E. (i), (ii) and (iv) only

15. Consider the following Python code snippet.

```
mySocket = socket(AF_INET, SOCK_STREAM)
mySocket.connect(('sunfire.comp.nus.edu.sg', 2105))
```

Suppose no runtime exception is raised, what port number is **mySocket** bound to when above statements finish execution?

A. It depends on the remote host's port that's making the connection.
B. TCP port 2105
C. Cannot say; it's operation system dependent and is usually a randomly chosen port.
D. UDP port 2105
E. None of the rest

16. A Go-Back-N sender just receives an ACK packet with ACK number 14. This ACK number falls within sender window which has the window size 6. Every data packet embeds a k-bit sequence number field (k is a constant unknown to you).

Which of the following definitely CANNOT be the sequence number of the next packet transmitted by the sender?
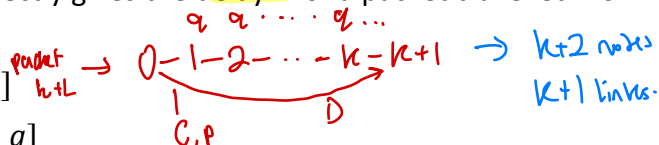
A. 4
B. 9
C. 15
D. 19
E. 20

17. Consider sending a packet over a path from node 0, through nodes 1, 2, ..., till node K+1. The links, from node i to node i+1, for i = 0, 1, ..., K each has the same link transmission rate C (in bits/s) and propagation delay p (in seconds). The packet has h header bits and L data bits.

    The delay D of a packet from node 0 to node K+1 is defined to be the duration from when the last bit of the packet leaves node 0 to when the last bit of the packet arrives at node K+1. Suppose the delay also includes a processing time of q seconds in each of the nodes 1, 2, ..., K. The processing time includes the waiting time in the queue.

    Which of the following formula correctly gives the delay D of a packet travelled from node 0 to node K+1?

    A. $D = p + K[(L+h)/C + p + q]$

    B. $D = (K+1)[(L+h)/C + p + q]$

    C. $D = p + K[(L+h)/C] + (K+1)q$

    D. $D = (K+1)p + K[(L+h)/C] + q$

    E. None of the rest

(handwritten annotations):
-1 node
packet $\rightarrow$ $0-1-2-\cdots-k-k+1$ $\rightarrow$ $k+2$ nodes, $k+1$ links
q q $\cdots$ q $\cdots$
$h+L$
C, P D
Total propagation delay $= (k+1)(p)$
Total transmission delay $= (k)\left(\frac{h+L}{C}\right)$
Total processing delay $= kq$
$\therefore D = p + kp + kq + h\left(\frac{h+L}{C}\right) = p + k\left(p+q+\frac{h+L}{C}\right)$.
B- A

Section II. SHORT QUESTIONS

Your answer for each of the following questions should be a single number (without any extra character such as blank space).

18. A file of size 9990 bytes is transferred over a TCP connection. The connection is still open after file transmission. MSS is 1000 bytes and TCP sends as much data as possible in a segment. *(handwritten: exclusive of header)*

    Assume TCP header is 20 bytes, what is the size of the last TCP segment (including TCP header and file data)?

(handwritten annotations):
must be of same (max) size?
190 bytes.   1010 bytes
$\frac{9990}{1000} = 9.99 \approx 10$ segments
$\therefore \frac{9990}{10} = 990$ $\therefore 990 + 20 = 1010$.

19. What is the checksum (1's complement of the sum) of the following 3 bytes?

    11110100
    10010101
    11011101

    (handwritten underlined answer): 1000111

(handwritten computation):
```
  1 1 1 1
  1 1 1 0 1 0 0
+ 1 0 0 1 0 1 0 1
 ─────────────
  1 0 0 0 1 0 0 1
+           1
 ─────────────
  1 0 0 0 1 0 1 0
+ 1 1 0 1 1 1 0 1
 ─────────────
  0 1 1 0 0 1 1 1 1
+           1
 ─────────────
  0 1 1 0 1 0 0 0
→ 1 0 0 1 0 1 1 1
```

**20.** Two hosts A and B are separated by a router R in between. The bandwidth of the links between A and R and between R and B are 1 Kbps and 2 Kbps respectively. Ignore all other kind of delays. Suppose A sends $8*10^4$ bits to B as a series of consecutive packets of 1000 bits each, when (in seconds) will B receive all the data?

(handwritten annotations)

no propagation

Last packet pushed onto link at $\left(80 \times \frac{1000}{1000}\right)$ s $+ 0.5$ s $\rightarrow$ to pushed onto RB.

1 Kbps   R   2 Kbps   B
A
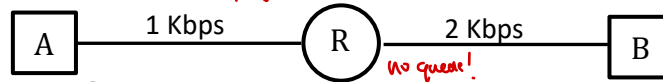
no queue!

$80000\ b \rightarrow 1000\ bits.$

120 s.

80.5 s.

$80 \times \left(\frac{1000}{10^3} + \frac{1000}{2 \times 10^3}\right) = 120$

Last packet $= 80 \times \frac{1000}{10^3} + 0.5$
$= 80.5.$

Suggested answers

1. B	8. E	15. C
2. A	9. C	16. B
3. B	10. B	17. A
4. C	11. A	18. 1010
5. D	12. A	19. 10010111
6. C	13. D	20. 80.5
7. A	14. B	