

**INSTRUCTIONS**

1. This mock paper should be completed in 1 hour (real midterm assessment is 1 hour 15 minutes).
2. The midterm assessment is open book. Calculators are allowed, but not laptops or other electronic devices.
3. The midterm assessment has two types of questions: MCQ and MRQ. You need to bring a 2B pencil to shade on the OAS form.

**Please DO NOT upload questions and answers onto the Internet.**

**Part I. Multiple Choice Questions (MCQs)**

1. Which of the following statement 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.
2. 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.  $2n$   
E. None of the above
3. Which of the following is the most appropriate description of the service provided by UDP?  
☒ 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

4. Which of the following statement 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 cable modem.
  - ☒ E. None of the above
5. Which of the following statement 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. Circuits must be reserved before *A* can pass the packet to *B*.
  - ☒ E. None of the above
6. Which of the following statement regarding TCP is TRUE?
- ☒ A. If a TCP segment has sequence number  $m$ , then ACK for this segment will have sequence number  $m + 1$ .
  - ☒ B. If a TCP segment has sequence number  $m$ , then ACK for this segment will have acknowledgement number  $m + 1$ .
  - ☒ C. Host *A* is sending a file to Host *B* over a TCP connection. Assume Host *B* has no data to send Host *A*. Host *B* will not send acknowledgments to Host *A* because Host *B* cannot piggyback the acknowledgments on data.
  - ☒ D. Host *A* is sending a file to Host *B* over a TCP connection. If the sequence number of a TCP segment is  $m$ , then the sequence number of the subsequent segment must be greater than  $m$ .
  - ☐ E. None of the above
7. 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

8. Consider sending a sequence of packets from a host in NUS to another host in NTU. 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 above

9. Which of the following statement about TCP initial sequence number (ISN) is TRUE?

~~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 above

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

~~A.~~ 255.254.255.0  
 B. 255.255.208.0  
 C. 255.240.0.0  
 D. 255.232.0.0  
~~E.~~ 127.0.0.0

128 64 32 16 8  
 |  
 192

11. **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 (iii) only  
 D. (ii), (iii) and (iv) only  
 E. (i), (ii) and (iv) only

12. 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. TCP also adds 20 bytes header to each segment.

What is the size of the last TCP segment?

- ☒ A. 1010  
☐ B. 990  
☐ C. 1000  
☐ D. 210  
☐ E. None of the above

$$990 + 20$$

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

11110100

10010101

11011101

- A. 10101100  
☒ B. 01101000  
☐ C. 10010111  
☐ D. 10011001  
☐ E. None of the above

$$\begin{array}{r}
 11110100 \\
 + 10010101 \\
 \hline
 10001001 \\
 1 \\
 \hline
 10001010 \\
 + 11011101 \\
 \hline
 01100111 \\
 + 01100111 \\
 \hline
 10010111
 \end{array}$$

→ 10010111

14. Consider a sender and a receiver communicating using **Selective Repeat** protocol. After transmitting for a while, the first and the last sequence numbers in the sender's window are  $k$  and  $k+3$  respectively. Let a packet with sequence number  $i$  be  $p_i$ . Which of the following statement MUST be TRUE?

- ☒ A.  $p_k$  is sent by the sender and ACK sent by the receiver.  $p_k$  is lost.  
☒ B. If  $p_{k+2}$  is not sent,  $p_{k+1}$  is also not sent. *send together in a window*  
☐ C. Receiver is currently expecting  $p_k$ . *maybe*  
☒ D. If sender has sent  $p_{k+3}$ , it has not received ACK for this packet. *maybe*  
☒ E. None of the above

$$k \quad k+1 \quad k+2 \quad k+3$$

15. A **Go-Back-N** sender just receives an ACK packet with sequence number 14. This ACK number falls within sender's window. Sender's window size is 6. Every packet embeds a  $k$ -bit sequence number field ( $k$  is an unknown constant). Which of the following definitely CANNOT be the sequence number of the next packet transmitted by the sender?

- ☒ A. 9  
☒ B. 4  
☒ C. 15  
☒ D. 19  
☒ E. 20

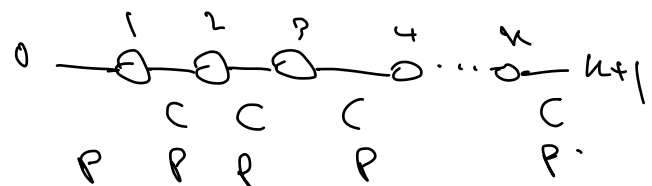
14 15 0 1 2 3 4 .  
 . 15 16 17 18 19 20

16. 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  $i = 0, 1, \dots, K$  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 above



$$D = Kq + K\left(\frac{L+h}{C}\right) + (K+1)p$$

$$p + K\left(q + \frac{L+h}{C} + p\right)$$

## Part II. Multiple Response Questions (MRQs)

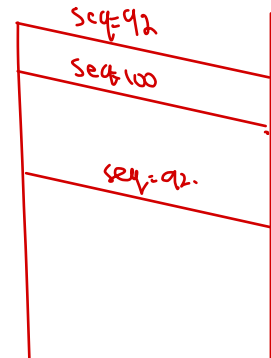
17. Consider the sequence of events recorded by a host in a TCP connection:

→ SEND PKT(seq=92, size=8)  
 → SEND PKT(seq=100, size=5)  
 → SEND PKT(seq=92, size=8)  
 ← RECV ACK(ack=105)  
 ← RECV ACK(ack=105)

*Handwritten notes:*  
 } both must be received.  
 } must be received.  
 } x2

What are the possible events that could have happened?

- ☒ A. Lost Message
- ☒ B. Server Failure
- ☒ C. Premature Timeout
- ☒ D. Fast Retransmission
- ☒ E. Lost ACK

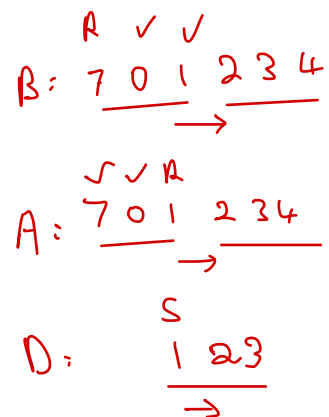


18. Consider a Go-Back-N reliable transmission protocol with a k-bit sequence number and sending window of size 3 operating over a channel that can delay, corrupt or lose packets, but not reorder them.

The sender has just sent a new packet with sequence number 2.

Which of the following events could have directly preceded (came before) this (i.e. no other packets were sent or received in between)?

- ☒ A. Sender received an ACK with sequence number 1
- ☒ B. Sender received an ACK with sequence number 7
- ☐ C. Sender sent a packet with sequence number 0
- ☒ D. Sender sent a packet with sequence number 1
- ☐ E. Sender sent a packet with sequence number 4



A client sends an HTTP Request to a server. The response below will be used for Question 17 and 18.

HTTP/1.1 301 Moved Permanently  
 Location: https://www.google.com/gmail/  
 Content-Type: text/html; charset=UTF-8  
 X-Content-Type-Options: nosniff  
 Date: Sun, 23 Sep 2018 01:06:12 GMT  
 Expires: Tue, 23 Oct 2018 01:06:12 GMT  
 Server: sffe  
 Content-Length: 226  
 X-XSS-Protection: 1; mode=block  
 Cache-Control: public, max-age=2592000  
 Age: 917718

<HTML><HEAD><meta http-equiv="content-type"  
 content="text/html; charset=utf-8">  
 <TITLE>301 Moved</TITLE></HEAD><BODY>  
 <H1>301 Moved</H1>  
 The document has moved  
 <A HREF="https://www.google.com/gmail/">here</A>.  
 </BODY></HTML>

19. Which of the following statements can be **definitively** made from just observing the response?

- ☒ a. The client was attempting to send an email through the server.
- ☒ b. The web server was unreachable.
- ☒ c. DNS resolution has failed.
- ☒ d. The connection was closed immediately after receiving the response.
- ☒ e. The length of the TCP segment containing the body of the response is 246 bytes.

20. What would be a **possible** event that happens directly after receiving such a response?

- ☒ a. The client will send another HTTP request over the current TCP connection.
- ☒ b. The client will close the current connection and initiate a new TCP connection to www.google.com
- ☒ c. The client will switch over to use UDP to connect to www.google.com
- ☒ d. The client will initiate DNS lookup for www.google.com
- ☒ e. The client will raise a "Host Not Found" exception.

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**Suggested answers**

**1. B**

**2. C**

**3. A**

**4. B**

**5. A**

**6. E**

**7. D**

**8. C**

**9. D**

**10. C**

**11. B**

**12. A**

**13. C**

**14. E**

**15. A**

**16. A**

**17. C & E**

**18. A, B & D**

**19. None**

**20. A, B & D**