Please DO NOT upload questions and answers onto the Internet.

Part I. Multiple Choice Questions (MCQs)

1. Which of the following statements about HTTP is FALSE?

   A. HTTP typically runs on top of TCP.
   B. HTTP is an application layer protocol.
   C. In HTTP/1.0, the server will usually close the connection after every request.
   D. In HTTP/1.1, the default connection type is persistent.
   E. HTTP is only used to download HTML data from a Web server.

2. UDP uses _____ to dispatch incoming packets to different processes in the same host.

   A. multiplexing
   B. de-multiplexing
   C. congestion control
   D. flow control
   E. IP address

3. Which of the following statement about DNS is FALSE?

   A. DNS provides hostname to IP address mapping.
   B. A hostname may be mapped to multiple IP addresses.
   C. All DNS queries must go to the root servers.
   D. DNS servers typically listen to UDP port 53.
   E. Failure to contact DNS servers can cause disruption in access to Internet services.

4. A port number in TCP is _____ bytes long.

   A. 1
   B. 2
   C. 4
   D. 16
   E. 32

5. In a _____ network, data is first divided into manageable chunks before being sent.

   A. connection-oriented
   B. connection-less
   C. circuit-switching
   D. packet-switching
   E. telephone

6. The _____ layer of the Internet protocol stack is responsible for delivering data from sending process to receiving process.

   A. application
   B. transport
   C. network
   D. link
   E. physical

7. In HTTP, a response status code of 404 tells you

   A. Web server is unavailable
   B. Web server is currently busy
   C. your browser needs to be updated to the latest version
   D. the requested Web object is not found
   E. your HTTP request is malformed

8. It's said that a TCP Client/Server connection formation is "asymmetric" because a TCP server must exist before a TCP client can communicate with it. What can be said about UDP-based connection formation?

   A. A UDP client may send data to a non-existing UDP server without noticing that server is offline.
   B. A UDP server must exist before a client can send data to it. Otherwise client will encounter an exception.
   C. A UDP client and server must exchange control information before the client can send data to the server.
   D. Two UDP clients on one host cannot communicate with the same UDP server at the same time.
   E. None of the above

9. Which of the following is a correct description of **`nslookup`**?

   A. It is used to check network connectivity to destination host.
   B. It is used to trace the network path between source and destination hosts.
   C. It is used to show network configuration of a host.
   D. It is used to find the DNS mapping between hostname and IP address.
   E. None of the above

10. 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?

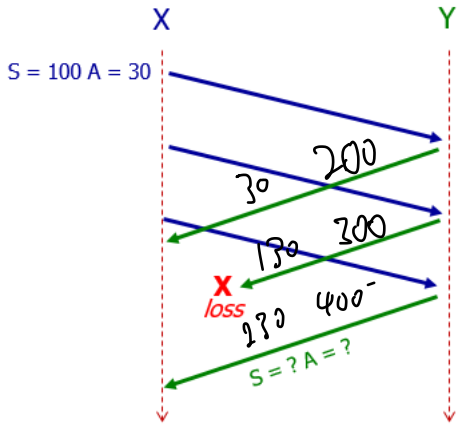
   A. It depends on the remote host's port that's making the connection.
   B. TCP port 2105
   C. Cannot say; it's operation system dependent and is usually a randomly chosen port.
   D. UDP port 2105
   E. None of the above

11. A huge file is transferred over an existing TCP connection (i.e., 3-way handshake is already done). The connection is still open after transmission. The first and last TCP segments have the sequence numbers 12,345 and 2,105 respectively. MSS is 1,024 bytes and TCP sends as much data as possible in a segment.

    How many TCP segments are used to transfer the file, assuming the communication channel is perfectly reliable?

   A. 10
   B. 4,194,295
   C. 4,194,303
   D. 33,554,360
   E. 8,388,598

12. The following diagram shows two hosts **X** and **Y** communicating over a channel using TCP. **X** and **Y** are sending data to each other (recall that TCP supports bi-directional communications). Each segment contains 100 bytes of data. None of the segments shown in the figure are retransmitted packets, nor are they corrupted. However, the second segment send by **Y** is lost. There are no other unacknowledged segments.



What could be the sequence number (S) and acknowledgement number (A) in the last segment send by Y?

A. S = 300, A = 130

B. S = 130, A = 300

C. S = 400, A = 230

D. S = 230, A = 400

E. S = 330, A = 400

13. Consider a sender and a receiver communicating using Selective Repeat protocol. Every packet embeds a 3-bit sequence number field. Sender just sends a packet with sequence number 6. Sender's window size is 3.

Which of the following CANNOT possibly be the sequence number of the next packet transmitted by sender?

A. 0

B. 2

C. 4

D. 5

E. 6

4 5 6 7 0.

14. A sender and a receiver communicate over an unreliable channel of the following characteristics: **packets may be lost or delayed for arbitrarily long time but won't be corrupted or reordered**.

    We would like to design a stop-and-wait, NAK-free protocol called rdt 4.0 to ensure reliable transmission. In rdt 4.0, sender keeps a timer for a sent but unacknowledged packet. When timer expires, sender deems the packet is lost and will retransmit it.

    You are to design other features of rdt 4.0 to make it a reliable protocol for the given scenario. The features you design must not conflict with the features/specifications given above.

    Which of the following statement about your rdt 4.0 is TRUE?

    A. Receiver may receive duplicate packets. However, receiver should simply ignore duplicate packets and do not send ACKs.

    B. Receiver must maintain a timer for the ACK sent. If no packet arrives before timer expires, receiver should retransmit the ACK.

    C. Sender must resend data packet if a duplicate ACK is received.

    D. Sender won't receive duplicate ACKs at all.

    E. None of the above

15. Suppose two hosts are connected by a direct link of 1 Mbps. A stop-and-wait protocol is used to transfer 10 packets from the sending host to the receiving host. Each packet is 1000 bytes long. RTT is 24 milliseconds. No packet is lost or corrupted during transmission and ACK packets are of negligible size.

    What is the throughput of the transmission?

    A. 0.25 Mbps

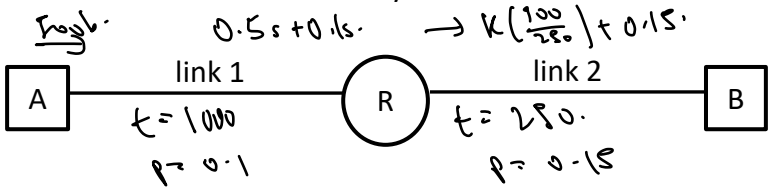
    B. 0.04 Mbps

    C. 0.87 Mbps

    D. 0.77 Mbps

    E. 1 Mbps

16. Two hosts **A** and **B** are connected by a router **R** as shown in the following diagram.



    For link 1, link transmission rate is 1 Kbps and propagation delay is 100 milliseconds. For link 2, link transmission rate is 250 bps and propagation delay is 150 milliseconds. Suppose Host **A** sends 2000 packets to Host **B** continuously and each packet is 500 bits long. Host **A** starts sending the 1st packet at time $t = 0$.

    When (in seconds) will Host **B** receive the k^{th} packet ($1 \le k \le 2000$)?

    A. $0.75 + 2k$

B. $2.75k$

C. $0.6 + 2k$

D. $0.6 + 2.15k$

E. None of the above

Part II. Multiple Response Questions (MRQs)

Write your answer in the box provided in each question. There is no need to show your working.

17. The first segment sent by a sender over TCP has the sequence number 10,000 and the last segment sent has the sequence number 90,000. Assuming that every data segment sent contains exactly 1,000 bytes of data, how many ACK segments could the receiver have **possibly** sent?

    a. 11

    b. 21

    c. 41

    d. 81

    e. 121

The following output from `dig` will be used for Question 18 and 19:

```
; <<>> DiG 9.6-ESV-R11-S10 <<>> nus.edu.sg any
;; global options: +cmd
;; Got answer:
;; ->>HEADER<<- opcode: QUERY, status: NOERROR, id: 25738
;; flags: qr rd ra; QUERY: 1, ANSWER: 15, AUTHORITY: 2, ADDITIONAL: 2

;; QUESTION SECTION:
;nus.edu.sg.                    IN    ANY

;; ANSWER SECTION:
nus.edu.sg.             1800    IN    MX    mailgw0.nus.edu.sg
nus.edu.sg.             1800    IN    MX    mailgw1.nus.edu.sg
nus.edu.sg.             104     IN    A     137.132.21.27
nus.edu.sg.             932     IN    NS    ns2.nus.edu.sg.
nus.edu.sg.             932     IN    NS    ns1.nus.edu.sg.

;; AUTHORITY SECTION:
nus.edu.sg.             932     IN    NS    ns1.nus.edu.sg.
nus.edu.sg.             932     IN    NS    ns2.nus.edu.sg.

;; ADDITIONAL SECTION:
ns1.nus.edu.sg.         4621    IN    A     137.132.123.4
ns2.nus.edu.sg.         3236    IN    A     137.132.5.2
mailgw0.nus.edu.sg.     86400   IN    A     137.132.20.32
mailgw1.nus.edu.sg.     86400   IN    A     137.132.49.5

;; Query time: 1 msec
;; SERVER: 137.132.85.2#53(137.132.85.2)
;; WHEN: Thu Oct 04 04:26:02 SGT 2018
;; MSG SIZE  rcvd: 968
```

18. According to the dig output above, which of the following IP addresses belong to a DNS server?

    a. 137.132.5.2
    b. 137.132.21.27
    c. 137.132.49.5
    d. 137.132.85.2
    e. 137.132.123.4

19. According to the dig output above, which IP addresses should a host connect to in order to deliver an email to waikay@nus.edu.sg

    f. 137.132.5.2
    g. 137.132.21.27
    h. 137.132.49.5
    i. 137.132.85.2
    j. 137.132.123.4

New!

20. Consider a Selective-Repeat 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 receiver has just sent an ACK before receiving a packet with sequence number 1.

    What are the possible sequence numbers for the ACK that was sent?

    a. 0
    b. 2
    c. 3
    d. 5
    e. 7

7 0 1 2 3

Please DO NOT upload questions and answers onto the Internet.

Suggested answers

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