NATIONAL UNIVERSITY OF SINGAPORE

FINAL ASSESSMENT FOR
CS2105 – INTRODUCTION TO COMPUTER NETWORKS

(Semester 2: AY2015/2016)

Please DO NOT upload questions and answers onto the Internet.

Time allowed: 2 hours

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INSTRUCTIONS TO CANDIDATES

1. This assessment paper contains **SEVEN** (7) questions and comprises **SEVEN** (7) printed pages, including this page.

2. This is an **OPEN BOOK** assessment.

3. The maximum possible score is **60 marks**.

4. Calculators are allowed, but not laptops, PDAs, or other electronic devices.

5. Write all your answers on the **ANSWER SHEETS** provided.

6. Submit only the **ANSWER SHEETS** at the end of the assessment. You may keep the question paper.

Q1. Multiple Choice Questions (MCQs)   **[Total: 20 marks]**

Each MCQ has one correct answer and is worth 2 marks.

1.1 CSMA/CD is a (an) _____ layer protocol.

   A. application

   B. transport

   C. network

   D. link

   E. physical

1.2 Which of the following command will NOT cause a DNS query to be issued?

   A. `dig www.comp.nus.edu.sg`

   B. `nslookup www.nus.edu.sg`

   C. `telnet localhost 9000`

   D. `ping sunfire.comp.nus.edu.sg`

   E. `traceroute ivle.nus.edu.sg`

1.3 Ethernet provides an unreliable service. Therefore,
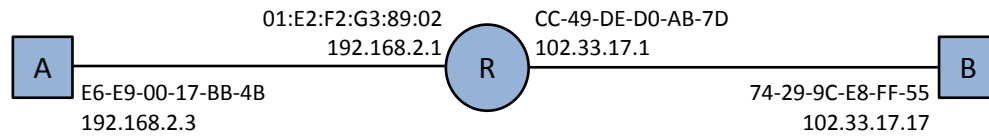
   A. CRC is not used for error checking.

   B. Ethernet sends a negative acknowledgement to the sender to indicate packet loss.

   C. Ethernet drops a frame that fails error checking without retransmission.

   D. Ethernet does not function correctly when bit errors in frames are detected.

   E. applications that require reliable delivery cannot run over Ethernet.

1.4 Which of the following field(s) in an IP datagram header will be changed by a router?

    i.   TTL

    ii. Checksum

    iii. Identifier

    iv. Upper layer protocol

   A. (ii) only

   B. (ii) and (iii) only

   C. (i) and (ii) only

   D. (i) only

   E. (i), (ii), (iii) and (iv)

1.5 Which of the following is an INVALID subnet mask?

    A. 255.255.255.0
    B. 255.255.252.0
    C. 255.192.0.0
    D. 255.255.255.224
    E. 255.255.244.0

1.6 A Web server supports both HTTP/1.0 and HTTP/1.1. So far 100 clients have downloaded a web page from the server, which contains 1 HTML file and 2 images. Half of the clients run HTTP/1.0 and the other half run HTTP/1.1.

    How many sockets has the Web server ever created?

    A. 201
    B. 200
    C. 100
    D. 101
    E. None of the above

1.7 Which of the following statement is FALSE?

    A. When a router receives an IP datagram with destination address 255.255.255.255, it must broadcast this IP datagram on all the interfaces except the interface this datagram is received.
    B. One of the benefits of segmenting a big chunk of data into smaller packets for transmission in the Internet is to lower end-to-end delay.
    C. MSS specifies the maximum size of a TCP segment, exclusive of the size of TCP header.
    D. Hosts in the same subnet communicate with each other without intervening a router.
    E. The maximum size of an IP datagram that can be transmitted over a link is restricted by the link MTU.

1.8 Given the CRC generator `1001`, which of the following bit sequence received by receiver is not corrupted?

    A. `11000010`
    B. `11000111`
    C. `11000110`
    D. `11000011`
    E. `11000001`

1.9 Host A and B are connected by a NAT-enabled router R as shown in the following diagram. Suppose A sends a packet to host B and B replies with a packet. What is the destination IP address and MAC address in the packet replied by B?

01:E2:F2:G3:89:02
192.168.2.1
R
CC-49-DE-D0-AB-7D
102.33.17.1

A
E6-E9-00-17-BB-4B
192.168.2.3

B
74-29-9C-E8-FF-55
102.33.17.17

A. Dest IP address: 102.33.17.1; dest MAC address: E6-E9-00-17-BB-4B
B. Dest IP address: 102.33.17.1; dest MAC address: CC-49-DE-D0-AB-7D
C. Dest IP address: 192.168.2.3; dest MAC address: E6-E9-00-17-BB-4B
D. Dest IP address: 192.168.2.3; dest MAC address: CC-49-DE-D0-AB-7D
E. Dest IP address: 192.168.2.1; dest MAC address: CC-49-DE-D0-AB-7D

1.10 A Go-back-N sender just receives an ACK packet with sequence number t. Before this ACK is received, sender's window is $[k, k + N - 1]$ where N is the window size. Suppose $k > N$, packets may be lost or corrupted but will not be reordered. What is the smallest possible value of t?

A. $k - 1$
B. k
C. $k - N + 1$
D. $k - N$
E. None of the above

Q2. **[Total: 6 marks]**

(a) **[2 marks]** A modem is designed for use over a telephone link, for which the available channel bandwidth is 3 kHz, and the average signal to noise ratio on the channel is 511. What is the maximum error-free data rate that can be supported on this channel?

(b) **[2 marks]** 1.8 Mb of data is transmitted in 60 seconds using 8-PSK. What is the baud rate of the signal?

(c) **[2 marks]** What bit pattern does the following NRZ-I diagram represent? Suppose the first bit is 0.
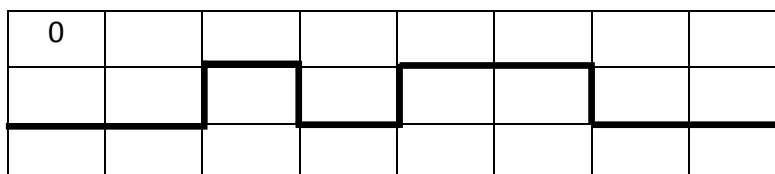
Q3.   **[Total: 7 marks]**

(a) **[2 marks]** After issuing the command `nslookup www.yahoo.com`, the following output is observed.

>   Server: 203.211.152.66
>
>   Address: 203.211.152.66#53
>
>   Non-authoritative answer:
>
>   www.yahoo.com   canonical name = fd-fp3.wg1.b.yahoo.com.
>
>   Name: fd-fp3.wg1.b.yahoo.com
>
>   Address: 106.10.138.240
>
>   Name: fd-fp3.wg1.b.yahoo.com
>
>   Address: 106.10.139.246

What are the IP address and port number of the DNS server that answers this DNS query?

(b) **[2 marks]** The _____ field in IP header prevents an IP datagram from continuously wandering through the Internet.

(c) **[3 marks]** A subnet has 16384 IP addresses and one of the IP is 58.26.177.105. What is the first IP address in this subnet?

Q4.   **[Total: 4 marks]**

Two hosts A and B are connected via a router. The link rate is 1 Mbps and propagation delay is 40 ms per link. The maximum size of a packet is 1 Kb and packet header is 80 bits. Suppose sender sends as much data as possible in a packet, packets are sent continuously and no packet is corrupted or lost during transmission.

How long (in milliseconds) does it take to send a 400 Kb file from A to B (from when the first bit of the first packet leaves A to when last bit of the last packet arrives at B)? Briefly show how you work out the answer.

Q5.   **[Total: 4 marks]**

Public key cryptography uses both public and private keys. Let Alice's public key be K_A^+ and private key be K_A^-, Bob's public key be K_B^+ and private key be K_B^-. Alice sends a message m to Bob. Describe how they can ensure message confidentiality and message authenticity using only these 4 keys.

Q6.   **[Total: 9 marks]**

Consider the network topology shown below. Each link is labelled with the cost (in dollars) of using that link. Every router runs distance vector routing protocol.
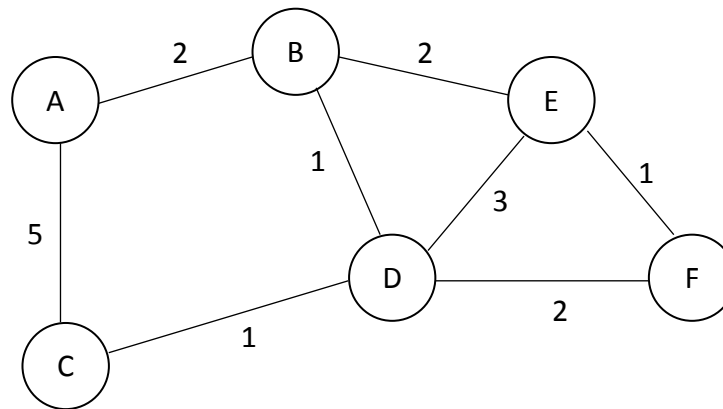
(a) **[2 marks]** Fill in the distance vector table for the initial distance vectors of routers A to C (i.e. before the distance vector protocol is executed). If a router is unaware of another router, write '–' in the corresponding slot.

(b) **[2 marks]** Suppose the distance vector protocol has terminated and each router knows the cost of the least cost path to every other router. Fill in the distance vector table for the final distance vectors of routers A to C.

(c) **[3 marks]** Routers C to F are the gateway routers to the following subnets.

| Subnets	Gateway routers
137.132.58.128/28	D
137.132.89.0/26	C, D
137.132.80.128/25	C, F
137.132.82.0/24	E

Use the result you get in (b) to derive the forwarding table of router A.

(d) **[2 marks]** Assume all the links have the same transmission rate. In no more than 50 words, explain why the forwarding table in (c) leads to inefficient use of network bandwidth?

Q7. [Total: 10 marks]

The following graph shows the time sequence graph for a TCP connection between host X and host Y. Each dot represents a TCP segment received at host Y, plotting the sequence number of the segment, versus the time at which it is received. A set of dots stacked above each other represents a series of packets that are received back-to-back by the receiver. The packet labelled with A is the first data packet sent by X. The packet labelled with D is a re-transmitted packet.
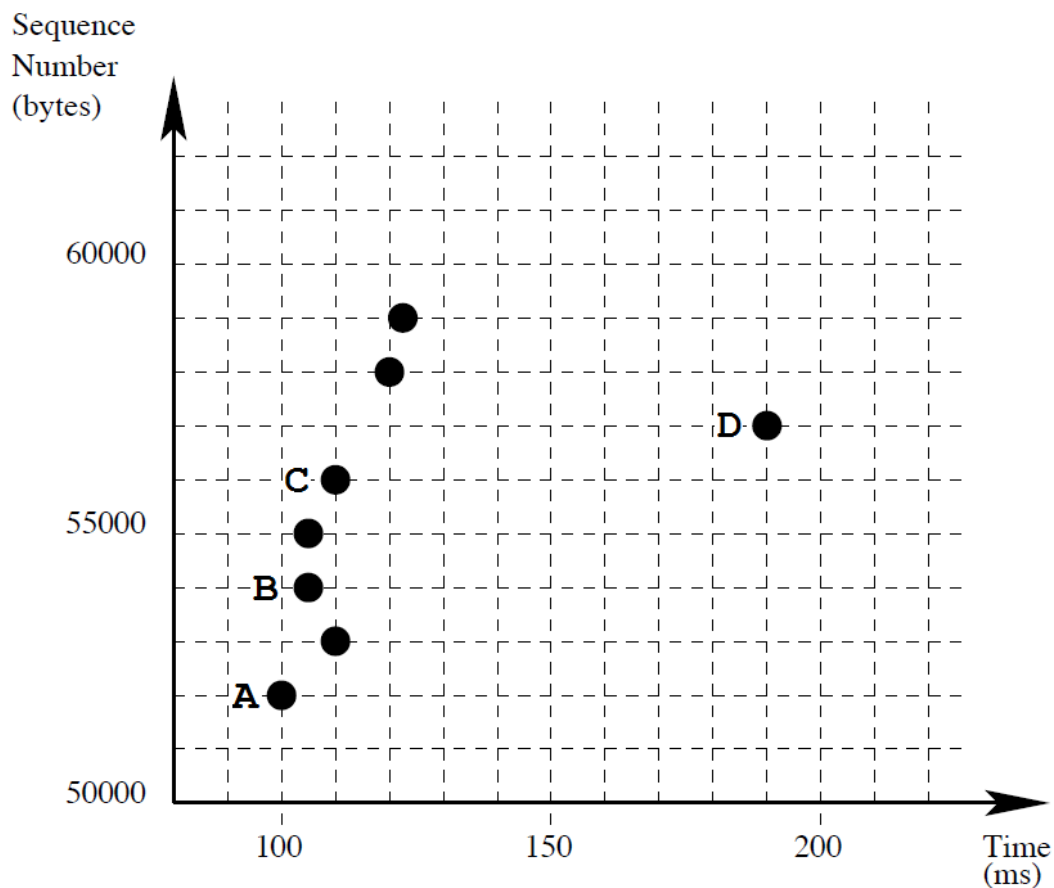
(a) **[2 marks]** How many bytes of data are there in each TCP segment?

(b) **[2 marks]** Suppose an acknowledgment is sent by Y at time 105ms, after receiving the packet labelled with B. What should be the acknowledgement number in this feedback packet?

(c) **[2 marks]** Does Y buffer out-of-order packets or discard them? Justify your answer in no more than 100 words.

(d) **[4 marks]** Suppose X sets a reasonable timeout value for this TCP connection. Retransmission is always successful. Estimate the timeout value that X chooses. Justify your answer and state clearly any assumptions you make.

=== END OF PAPER ===