Matriculation Number: | | | | | | | | | |

CS2105

NATIONAL UNIVERSITY OF SINGAPORE

SCHOOL OF COMPUTING
FINAL EXAMINATION FOR
Semester 2 AY2012/2013

CS2105 Introduction to Computer Networks

April 2013 Time Allowed 2 hours

INSTRUCTIONS TO CANDIDATES

1. This exam paper contains 15 questions and comprises 10 printed pages, including this page.
2. The total marks for this examination is 50. Answer **ALL** questions.
3. Write **ALL** your answers in the box provided. Please indicate clearly (with an arrow) if you use any space outside the box for your answer.
4. This is an **CLOSE BOOK** examination, but you are allowed to bring in **one sheet of double-sided A4 size paper** with notes.
5. Write your matriculation number on the top-left corner of every page.

EXAMINER'S USE ONLY		
Q1-10	20	
Q11	6	
Q12	4	
Q13	6	
Q14	9	
Q15	5	
TOTAL	50	

Part I
Multiple Choice Questions (20 points)

For each of the questions below, select the most appropriate answer and **write your answer in the answer box**. Each question is worth 2 points.

If multiple answers are equally appropriate, pick one and write the chosen answer in the answer box. Do NOT write more than one answer in the answer box.

If none of the answers are appropriate, write `X` in the answer box.

1. (2 points) Consider a Java implementation of a Web server that communicates with a back-end CGI script to implement a Web-based application.

   Which of the following step IS necessary to handle a POST request?

   A. Read the HTTP header from the socket and write the header into the standard input of the CGI process.

   B. Read the HTTP body from the socket and write the body into the standard input of the CGI process.

   C. Read the CGI script from the file and write the content of the file into the socket.

   D. Read from the standard output of the CGI process and store the output into a file.

   E. Parse the the query string from the HTTP header and write the query string into the standard input of the CGI process.

   Write `X` in the answer box if none of the choices above are necessary.

   Answer: ☐

2. (2 points) A given subnet contains two hosts with IP addresses 137.132.80.16 and 137.132.67.94 respectively. Which of the following is/are possible address block assigned to the subnet?

   (i) 137.132.64.0/18

   (ii) 137.132.64.0/19

   (iii) 137.132.64.0/20

   (iv) 137.132.64.0/21

   A. (i) only

   B. (i) and (ii) only

   C. (i), (ii), and (iii) only

   D. (iii) and (iv) only

   E. (iv) only

   Write `X` in the answer box if none of the choices above are correct.

   Answer: ☐

3. (2 points) Consider the following forwarding table in a router that uses longest prefix matching to forward packets. Assume that 4-bit addressing is used.

prefix	interface
X	1
Y	2
Otherwise	3

We know that packets with an address of 0100 are forwarded to Interface 1 and packets with an address of 0010 are forwarded to Interface 2.

Which of the following CANNOT be the values for X and Y?

A. $X = 0$ and $Y = 00$

B. $X = 01$ and $Y = 00$

C. $X = 010$ and $Y = 00$

D. $X = 01$ and $Y = 0$

E. $X = 0$ and $Y = 001$

Write `X` in the answer box if all choices above are possible values for X and Y.

Answer: ☐

4. (2 points) Two hosts are communicating over a link. A perculiar bug in the software may randomly swap the values of the least significant bits in the first two bytes of the data during transmission. Which of the following error detection scheme CAN always detect the error caused by this bug?

(i) A 1-D parity bit scheme where one parity bit is computed for every byte in the data.

(ii) An 8-bit checksum computed from every byte in the data.

(iii) An CRC-8 scheme with generator 100000001.

A. (i) only

B. (iii) only

C. (i) and (ii) only

D. (i) and (iii) only

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

Write `X` in the answer box if none of the choices above are correct.

Answer: ☐

5. (2 points) Which of the following statement about IP header is TRUE?

   A. The source and destination port numbers in the IP header determine which application on the receiving host will process the datagram.

   B. The TTL field in the IP header determines the time period within which the source IP address is valid.

   C. The 16-bit identifier field in the IP header is unique across IP packets received from the same source IP address.

   D. The checksum field in the IP header allows the receiver to check if the IP datagram is corrupted.

   E. The protocol field in the IP header determines which link layer protocol should be used to transmit the datagram.

   Write `X` in the answer box if none of the statements above are true.

   Answer: ☐

6. (2 points) To ensure that a collision is always detected, CSMA/CD uses a minimum frame size of L_{min}. Which of the following factor would lead to a larger L_{min}?

   A. Reducing the maximum allowable distance between any two hosts.

   B. Reducing the length of a bit.

   C. Reducing the transmission rate.

   D. Increasing the propagation speed.

   E. Increasing the number of hosts sharing the medium.

   Write `X` in the answer box if none of the choices above are correct.

   Answer: ☐

7. (2 points) Which of the following protocols is NOT involved in execution of the command `traceroute www.nus.edu.sg`?

   A. TCP

   B. UDP

   C. IP

   D. DNS

   E. ICMP

   Write `X` in the answer box if every protocol above is involved.

   Answer: ☐

8. (2 points) A host uses a variety of protocols to discover information about the network it is connected to. Which of the following statements is FALSE?

   A. To perform a DNS lookup, a host must first discover the IP address of its local DNS server using DHCP.

   B. To transmit a packet outside the host's subnet, the host must first discover the IP address of its first-hop router using DHCP.

   C. To send a packet to another host outside its subnet, a host must first discover the IP address of the destination host using DNS.

   D. To get an IP address assigned, a host must first discover the IP address of its DHCP server using DNS.

   E. To send a packet to another host in the same subnet, a host must first discover the MAC address of the destination host using ARP.

   Write `X` in the answer box if none of statements above are false.

   Answer: ☐

9. (2 points) Consider a noisy channel with a Shannon capacity of 100 kbps and a bandwidth of 10 kHz. The signal-to-noise ratio of this channel is

   A. 3.3

   B. 5

   C. 9

   D. 10

   E. 1023

   Write `X` in the answer box if none of the answers above are correct.

   Answer: ☐

10. (2 points) Which of the following digital-to-analog modulation scheme can support the highest data rate?

    A. PSK at 8000 baud

    B. QPSK at 8000 baud

    C. 4-QAM at 6000 baud

    D. 8-QAM at 4000 baud

    E. 16-QAM at 2000 baud

    Answer: ☐

Part II

Short Questions (30 points)

Answer all questions in the space provided. Be succinct and write neatly.

11. (6 points) Two hosts A and B are 2000 km apart and are connected directly using a link with propagation delay of 800 bit times and propagation speed of 2.5×10^8 m/s. A is sending a sequence of packets, each is 100 bytes in size, to B.

    (a) (3 points) How long does it take to transmit a packet on this link?

    (b) (3 points) A is using a sliding window protocol to communicate reliably with B. What is the minimum window size A should use for the link to be fully utilized (assuming the channel is reliable)?

12. (4 points) A switch has three interfaces, labelled 1 to 3, and an empty switching table (initially). The switch receives four frames consecutively in the order listed in the table below. The source, destination, and the inferface in which each frame is received is summarized in the table:

Source MAC Address	Destination MAC Address	Incoming Interface	Action
AA:AA:AA:AA:AA:AA	DD:DD:DD:DD:DD:DD	1	
BB:BB:BB:BB:BB:BB	AA:AA:AA:AA:AA:AA	2	
CC:CC:CC:CC:CC:CC	AA:AA:AA:AA:AA:AA	1	
DD:DD:DD:DD:DD:DD	BB:BB:BB:BB:BB:BB	3	

The action column in the table above refers to the action that the switch takes on each frame.

Complete the table above by filling in the action column. An action can be either "forward to x," where x is one of the interfaces, "broadcast," or "filter".

13. (6 points) A NAT-enabled router connects between a private subnet (LAN) and the public Internet (WAN). Tables 1 and 2 show the NAT translation table and part of the ARP table in the router respectively.

LAN-side IP Address, Port	WAN-side IP Address, Port
10.0.0.8, 8000	1.2.3.4, 50000
10.0.0.9, 9000	1.2.3.4, 60000

Table 1: NAT Translation Table

IP Address	MAC Address
10.0.0.8	88:88:88:88:88:88
10.0.0.9	99:99:99:99:99:99

Table 2: ARP Table

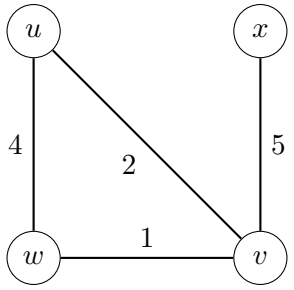
The router receives two packets, one on its interface connected to the public Internet (WAN), the other on its interface connected to the private subnet (LAN). The link, network, and transport layer addresses of the packets are shown in the following table, in the column labelled "Incoming."

The router forwards the packet received from the WAN onto the LAN, and forwards the packet received from the LAN onto the WAN. Some (or all) of the addresses in the outgoing packets have been modified by the router. Fill in the link, network, and transport layer addresses of these two outgoing packets in the tables below, in the column labelled "Outgoing."

Packet from WAN to LAN			
		Incoming	Outgoing
Source	MAC Address	33:33:33:33:33:33	
	IP Address	5.6.7.8	
	Port Number	80	
Destination	MAC Address	22:22:22:22:22:22	
	IP Address	1.2.3.4	
	Port Number	50000	

Packet from LAN to WAN			
		Incoming	Outgoing
Source	MAC Address	99:99:99:99:99:99	
	IP Address	10.0.0.9	
	Port Number	9000	
Destination	MAC Address	11:11:11:11:11:11	
	IP Address	5.6.7.8	
	Port Number	80	

14. (9 points) The figure below shows a small network consisting of four routers u, v, w, and x. The cost of each link is labelled on the graph. The routers run distance vector routing protocol *with poisoned reverse*. The protocol has converged and minimum cost paths have been computed.



(a) (3 points) Node v periodically receives distance vectors from its neighbors, shown in the empty tables below. Fill in the missing distance values.

From u

u	v	w	x
0			

From w

u	v	w	x
		0	

From x

u	v	w	x
			0

A new link, (u, x), is added to the network with a cost of 2. The routers u and x detect the new link, update their routing tables, and send a new distance vector to their respective neighbors.

(b) (3 points) After detecting the link (u, x), but before receiving the distance vector from u, x updates its routing table to the following. Fill in the new computed costs and next hops in x's new routing table below.

Destination	Next Hop	Cost
u		
v		
w		

(c) (3 points) After receiving the distance vector from u, x updates its routing table to the following. Fill in the new computed costs and next hops in x's routing table below.

Destination	Next Hop	Cost
u		
v		
w		

15. (5 points) Alice has a series of messages $m_0, m_1, ...$ that she wants to send to Bob. She uses the following protocol. For each message m_i, she encrypts m_i and the sequence number i with her private key K_A^-, followed by Bob's public key K_B^+. The resulting message $M_i = K_B^+(K_A^-(m_i \oplus i))$ is concatenated with its hash $H(M_i)$ (where H is a cryptographic hash function) and transmitted to Bob.

    Assume that (i) public key cryptography and cryptographic hash function are secure, and (ii) the certificate authorities can be trusted. For each of the following statements about the security of the protocol, indicate if the statement is TRUE or FALSE. Explain your answer briefly, in no more than two sentences.

    (a) (1 point) Only Bob can decrypt the received M_i to obtain m_i

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    (b) (1 point) Bob can detect if M_i has been modified.

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    (c) (1 point) Bob can be sure that Alice created m_i.

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    (d) (1 point) Bob can detect a replay attack.

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    (e) (1 point) Bob can detect if someone intercepts and deletes a message from Alice (i.e., blocks the deliver of the message to Bob).

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END OF PAPER