NATIONAL UNIVERSITY OF SINGAPORE

SCHOOL OF COMPUTING
SEMESTER EXAMINATION FOR
Semester 2 AY2005/2006

CS2105 Computer Networking I

April 2006 Time Allowed 2 hours

MATRICULATION NUMBER: | | | | | | | | | |

INSTRUCTIONS TO CANDIDATES

1. This examination paper contains EIGHTEEN (18) questions and comprises TWELVE (12) printed pages, including this page.
2. Answer **ALL** questions.
3. Answer multiple choice questions in Part I of this examination using the OCR form provided.
4. Answer short questions in Part II of this examination using the answer space provided. Please indicate clearly (with an arrow) if you use any space outside the answer space for your answer.
5. This is an **OPEN BOOK** examination, but you are only allowed to bring in **one sheet of double-sided A4 size paper** with notes.
6. Write your matriculation number in the space provided above and on top-left corner of every page.

EXAMINER'S USE ONLY		
Question	Mark	Score
Q1-10 MCQ	20	
Q11 GBN	12	
Q12 FSM	12	
Q13 TCP	9	
Q14 LAN	12	
Q15 DV	9	
Q16 MAC	9	
Q17 HDTV	9	
Q18 Modem	8	
TOTAL	100	

Part I
Multiple Choice Questions (20 points)

For each of the question below, select the most appropriate answer and **shade your answer on the OCR form.** If multiple answers are equally appropriate, pick one and shade the chosen answer on the OCR form. Do NOT shade more than one answers on the OCR form. Each question is worth 2 points.

If none of the answers provided is appropriate, shade `E` on the OCR form..

1. Which of the following protocols runs on end-hosts AND intermediate packet-switches?

   (i) TCP
   (ii) ARP
   (iii) FTP
   (iv) ICMP

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

2. Consider the following Java code fragment.

   ```
   new DatagramPacket(sendData, sendData.length, address, 9876);
   ```

   Which of the following statements most appropriately describe the above code fragment?

   A. A UDP socket is created at port 9876.
   B. A UDP packet is created with data contained in variable `sendData`.
   C. A UDP connection is established to host with address `address` at port 9876.
   D. A UDP packet is sent to host with address `address` at port 9876.

3. Consider the sender's view of the sequence numbers in **Selective-Repeat** protocol. Suppose the first sequence number in the sender's window is k, and the last sequence number in the sender's window is $k + 3$. Let a packet with sequence number i be p_i. Which of the following MUST be TRUE?

   A. If p_{k+2} is acknowledged, then p_{k+1} must be acknowledged too.
   B. The receiver is currently expecting p_k.
   C. p_k is sent but not acknowledged.
   D. p_{k+3} is not sent but is usable.

4. Consider a subnet with subnet mask 137.132.80.96/27. Which of the following IP address belongs to a host in this subnet?

   A. 137.132.80.15
   B. 137.132.80.27
   C. 137.132.80.132
   D. 137.132.80.123

5. Consider a datagram network using *8-bit* host addresses. Suppose a router uses *longest prefix matching* and has the following forwarding table:

Prefix Match	Interface
00	0
01	1
010	2
1	3

   Consider the range of destination host addresses that is associated with interface 1. How many addresses are in that range?

   A. 128
   B. 64
   C. 32
   D. 16

6. Consider the CRC code, with generator G of 101. Suppose a receiver receives an 8-bit bit string. The first six bits are data and the last two bits are the CRC bits. Given that there is no bit error, which of the following MAY BE the bit string received?

   (i) 1101 1001
   (ii) 1011 0100
   (iii) 1111 1110

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

7. Which of the following statement is FALSE?

   A. The forwarding table in a switch maps MAC addresses to output ports.
   B. The ARP table maps IP addresses to MAC addresses.
   C. The DNS type NS record maps host names of name servers to their IP addresses.
   D. The NAT translation table maps port numbers to tuples (private IP address, port number).

8. In PCM, an increase in the sampling frequency generally leads to

   A. an increase in the number of bits required to represent each sampled amplitude.
   B. a decrease in the difference between sampled amplitudes.
   C. an increase in the sampling periods.
   D. a decrease in the number of quantization levels.

9. Synchronization and error-detection capabilities are the two important factors to consider in selecting a signaling format for digital data to be used in baseband coaxial cable and twisted-pair bus LAN. Which of the following encoding schemes should be considered in the decision?

   A. NRZI coding
   B. Pulse code modulation
   C. Differential Manchester coding
   D. Quadrature Amplitude Modulation

10. Which of the following is the correct ranking of various transmission media in decreasing order of data rate capability?

    A. Optical fiber, microwave transmission, coaxial cable, Cat3 twisted wire pair.
    B. Twisted pair wire, coaxial cable, optical fiber, microwave transmission.
    C. Coaxial cable, optical fiber, twisted wire pair, microwave transmission.
    D. Optical fiber, microwave transmission, Cat3 twisted wire pair, coaxial cable.

Part II

Short Questions (80 points)

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

11. (12 points) Consider a sender and a receiver, communicating using **Go-Back-N** protocol. The sender just sent a packet with sequence number 10. The protocol uses window size of 3 and sequence number space of 16. For each of the following sequence number, indicate whether it is possible for the next packet transmitted by the sender to have that sequence number. Justify your answer.

    (a) 7

    (b) 9

    (c) 12

    (d) 13

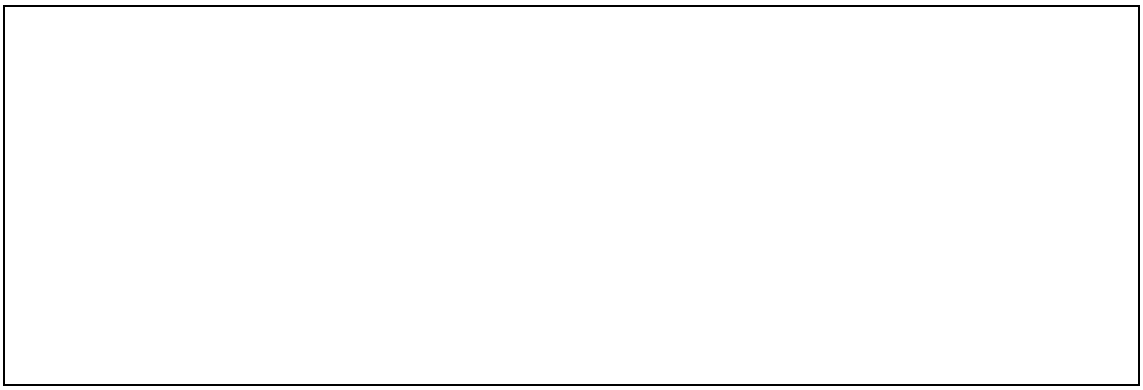
12. (12 points) Suppose we want to design a stop-and-wait, reliable protocol for communication between a sender S and a receiver R. The network resource at R is precious, therefore we do not want R to send ACK for every packet it receives. R only sends an NAK packet when it detects a corrupted packet. S uses a timer to check if a packet is received correctly. If a NAK is received before timeout, S will retransmit the packet. Otherwise, S is ready to send a new packet.

    The channel between R and S has the following properties:

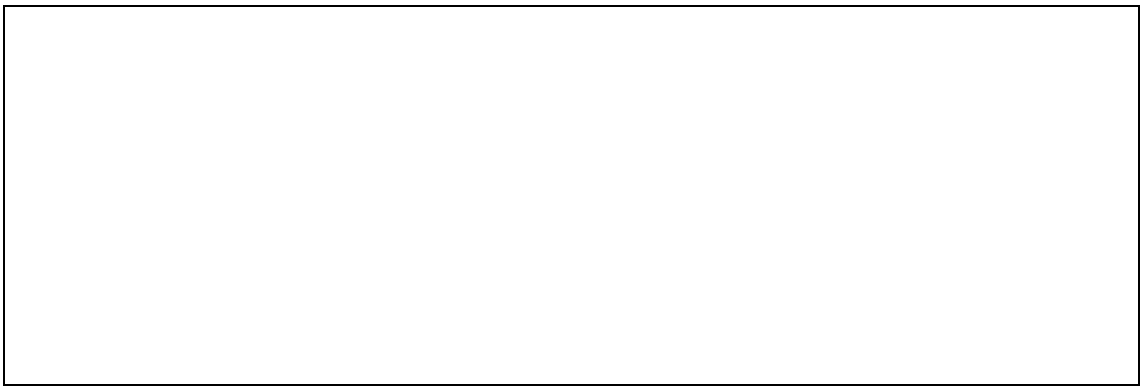
    - Packets can be corrupted from S to R
    - The channel from R to S is reliable.
    - Neither channel will loss packets.
    - Neither channel will reorder packets.
    - The maximum RTT between S and R is known and is guaranteed to be D.

    Based on the description above, you are to design a stop-and-wait protocol (i.e., both receiver and sender has a window size of 1) for reliable communication between S and R through the channel with the specified characteristics. Show your design by drawing the FSM for the sender side and receiver side of the protocol. You can use either the C-like notation in the textbook or the pseudo code notation shown in lecture to describe the events and actions in your FSM.

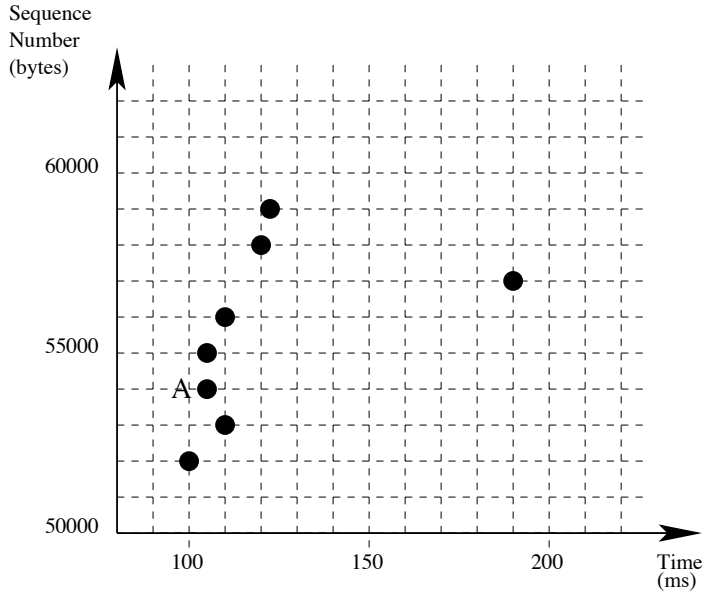
    FSM for Sender:

    FSM for Receiver:

13. (9 points) The following diagram shows the time sequence graph for a particular TCP connection between host X and host Y. Each dot represents a TCP segment received at a host X, plotting the sequence number of the segment, versus the time at which it was received. A set of dots stacked above each other represents a series of packets that were received back-to-back by the receiver.

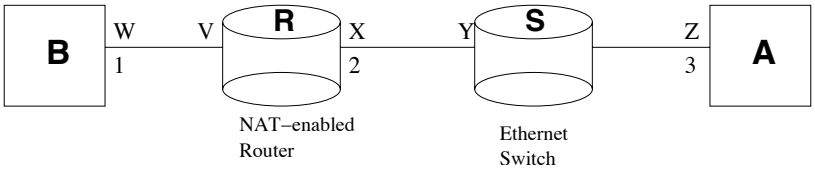


(a) How many bytes of data are there in each segment?

(b) Suppose an acknowledgment is sent by X at time 105ms, after receiving the packet labeled A. What should be the acknowledge number in this packet?

(c) *Estimate* the timeout value that Y uses for this TCP connection. Justify your answer. State any assumptions clearly. you make.

14. (12 points) The following diagram shows a LAN with two hosts, A and B. B is behind a NAT-enabled router R and has a private IP address. The router has a public IP address, and is connected to a switch S. The following tables show the (simplified) MAC addresses and IP addresses of the interfaces/ports/adaptors of the nodes shown in the diagram.



Interface	MAC address
B to R	W
R to B	V
R to S	X
S to R	Y
A to S	Z

Interface	IP address
B to R	1
R to S	2
A to S	3

Suppose A runs a Web server. B initiates connection to A, sends an HTTP request m to A. A replies with an HTTP response m'. The following questions concern the IP datagrams and Ethernet frames that encapsulate the messages m and m'.

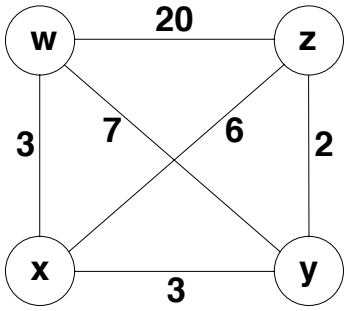
(a) What is the destination IP address of the datagrams sent from B? How does B obtain this destination IP address?

(b) What is the destination MAC address of the Ethernet frames sent from B? How does B obtain this destination MAC address?

(c) What is the destination IP address of the datagrams sent from A? How does A obtain this destination IP address?

(d) What is the destination MAC address of the Ethernet frames sent from A? How does A obtain this destination MAC address?

15. (9 points) The following diagram shows a simple network topology with 4 nodes. The links in the diagram are labeled with the cost of each link. The nodes run distance vector routing protocol. The protocol has terminated, and each node knows the cost of the minimum cost path to every other node.



(a) The following table shows an incomplete routing table at node x. Fill in the missing distance vector for x and z.

	cost to w	cost to x	cost to y	cost to z
from x		0		
from y			0	
from z				0

(b) Now, suppose the cost of the link between x and w increases from 3 to 20. Node x detects the changes in the cost for both links. Before x receives any new distance vector from its neighbors, triggered by these changes, x recomputes its new minimum-cost path to w, y and z, and updates its distance vector.

Suppose that poisoned reverse is NOT used. What is the new computed cost from x to w?

(c) Suppose that poisoned reverse is used. What is the new computed cost from x to w?

16. (9 points) Consider two nodes communicating using a multiple access protocol over a medium with transmission rate of 5×10^6 bps, and propagation speed of 2.5×10^8 m/s. The protocol transmits frames of size 100 bytes.

    Show all your workings for all parts below.

    (a) How long is one bit time?

    (b) What is the width (in meters) of a bit?

    (c) Assuming that the multiple access protocol divides time into time slots of size 800 bit time each, and nodes can begin transmitting only at the beginning of a slot. Further assume that a node A can detect collision if and only if it is still transmitting a frame when the signals transmitted by another node B reaches A. What is the maximum allowable distance between two nodes, so that collision can always be detected?

17. (9 points) A digitized high-definition television (HDTV) system operates with frames of 1920×1080 pixels at 30 frames per second. What is the data rate in bps generated by the system if each pixel uses 16,777,216 colors?

Assume that the HDTV frame is to be transmitted over a channel with 50 MHz bandwidth and a 40 dB signal-to-noise ratio. Find the capacity of the channel in bps. What is the significance of the result?

The standard for HDTV applies the MPEG-2 coding scheme in the system. The MPEG-2 coding can achieve a reduction from the uncompressed bit rate of 250 Mbps to an average of 4 Mbps. Can the channel support the transmission of the compressed HDTV frames? Why?

18. (8 points) An analog modem uses a coding scheme that has data points at the following coordinates: (-1, 0.5), (-1, -0.5), (-0.5, -1), (0.5, -1), (1, -0.5), (1, 0.5), (0.5, 1), and (-0.5, 1).

    (a) Draw the signal constellation for the modem.

    (b) What is the coding scheme used by the modem? How does the scheme use these data points to represent signal elements?

    (c) What is the data rate that the modem can achieve at 9,600 baud?

END OF PAPER