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

NATIONAL UNIVERSITY OF SINGAPORE

SCHOOL OF COMPUTING
SEMESTER EXAMINATION FOR
Semester 2 AY2010/2011

CS2105 Introduction to Computer Networks

APRIL 2011 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 lined area provided. Please indicate clearly (with an arrow) if you use any space outside the lined area for your answer.
4. This is an **CLOSED 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.

Question:	1	2	3	4	5	6	7	Total
Points:	2	3	3	2	2	2	3	17
Score:								

Question:	8	9	10	11	12	13	14	15	Total
Points:	2	3	3	4	2	1	7	11	33
Score:									

Part I
Short Questions

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

1. (2 points) A sender S is sending packets to a receiver R, using Selective Repeat. Both sender and receiver are using a window size of 3. We denote the packet with sequence number i as P_i. The first packet in the sending window of S is P_3.

   For each of the following statements, indicate if the statement is TRUE or FALSE. Briefly explain why.

   (a) S must not have received acknowledgement for P_3 yet.

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   (b) S may receive an acknowledgement for P_2.

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   (c) R must have received P_2 already.

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   (d) R may have already received P_6.

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2. (3 points) Two hosts A and B are connected with a 100 km, 100 Mbps, link. Signals propagate at the speed of 2.5×10^8 m/s on the link. What should the maximum TCP receiver window size (in bytes) for A and B be, in order to achieve maximum throughput? Show your workings.

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3. (3 points) A host A is connected to a home router R, which runs NAT.

   A has IP address 10.0.0.2. Router R has two interfaces. The one connecting to A has an IP address of 10.0.0.1, and the one connecting to the public Internet has an IP address of 137.132.88.88. A initiates connection to a Web server at address www.facebook.com (with an IP address of 69.63.189.31) at port 80, by sending a TCP SYN segment. Consider the IP datagram that encapsulates this TCP SYN segment.

   (a) When the datagram leaves A, what is the source IP address? what is the destination IP address?

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   (b) When the datagram leaves R, what is the source IP address? what is the destination IP address?

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   (c) The TCP SYN packet has a source port number p when it leaves A and a source port number of q when it leaves R. Show the entry in the NAT table that corresponds to this connection between A and www.facebook.com.

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4. (2 points) The following shows a forwarding table in a router that uses longest prefix matching and 4-bit addressing:

Prefix	Output Interface
10	A
1	B
x	C
default	D

   (a) Suppose that a packet with address 1001 is forwarded to output interface C. What are the possible values of x?

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   (b) How many possible addresses will be forward to output interface B? Justify your answer.

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5. (2 points) In a protocol where 1-complement checksum are computed over 8-bits data, the following three bytes are received: 10111000, 11110000, 01010110. One of the bytes is the 1-complement checksum (but we do not know which one).

   (a) Will the received bytes pass the checksum verification? Show your workings.

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   (b) Can you tell which bits contain error, if any? Explain.

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6. (2 points) In a network that runs distance vector routing algorithm with poison reverse, a host u receives the following distance vector from neighbor v.

Destination	Cost
w	3
x	5
y	7
z	∞

   u has only two neighbors, v and z.

   (a) When v receives a packet that is destined to z, which neighboring node of v would v send the packet to? Why?

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   (b) The link cost between u and v is 1. Suppose the current least cost path from u to w has a cost of c. What are the possible values of c, such that after receiving this new distance vector, u will update its least cost path to w to go through v?

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7. (3 points) To send a message m to Bob, Alice computes and sends $K_A^-(m)$ to Bob. Bob uses K_A^+ to compute m. K_A^- and K_A^+ are the private key and public key of Alice respectively.

   (a) Does this method ensure confidentiality? Why or why not?

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   (b) How can Bob be sure that this message comes from Alice?

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8. (2 points) Consider a LAN where nodes are connected using the bus topology and runs CSMA/CD. For each of the following statement, answer TRUE or FALSE. Briefly justify your answer (in one sentence).

   (a) If the link propagation speed increases (packet travels faster), the chances of collision is higher.

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   (b) If the transmission time of a frame increases, the chances of collision is higher.

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9. (3 points) A switch with 8 output interfaces just got rebooted and has an empty switching table. Soon after, it receives the following in order:

   - Frame 1, with source address x and destination address y on Interface 1
   - Frame 2, with source address y and destination address z on Interface 2
   - Frame 3, with source address z and destination address y on Interface 2

   Indicate, for each of the frames received, the action that the switch takes. An action can either be "broadcast", "filter", or "forward". If the action is forward, indicate which interface the frame is forwarded to.

   (a) Frame 1:

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   (b) Frame 2:

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   (c) Frame 3:

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10. (3 points) For each of the statements below, indicate if the statement is TRUE or FALSE. If you think the statement is FALSE, briefly explain why.

    (a) ARP table maps an IP address to a MAC address.

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    (b) Switch table of a switch maps an incoming interface to an outgoing interface.

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    (c) Forwarding table of a router maps an IP prefix to an outgoing interface.

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11. (4 points) A host has just been plugged into the network. It has no information about the network that it is connected to, and is trying to get an IP address. For each of the protocol below, indicates if the protocol is involved in this process, and if it so, briefly (in one sentence) explain the role of the protocol.

    (a) DNS

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    (b) DHCP

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    (c) ARP

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    (d) UDP

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12. (2 points) A noiseless channel uses 4 levels of signal to represent data and has a theoretical maximum bit rate of R bps.

    If we double the number of levels to 8, what is the new theoretical maximum bit rate? Show your workings.

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13. (1 point) 256-QAM modulation is used to transmit data at 256 kbps. What is the baud rate of the signal?

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Part II

Long Questions

14. Figure 1 shows the finite state machine of a protocol designed to run over a channel with the following properties: (P1) can corrupt packet, (P2) can loose packets, and (P3) has an unknown round trip time.

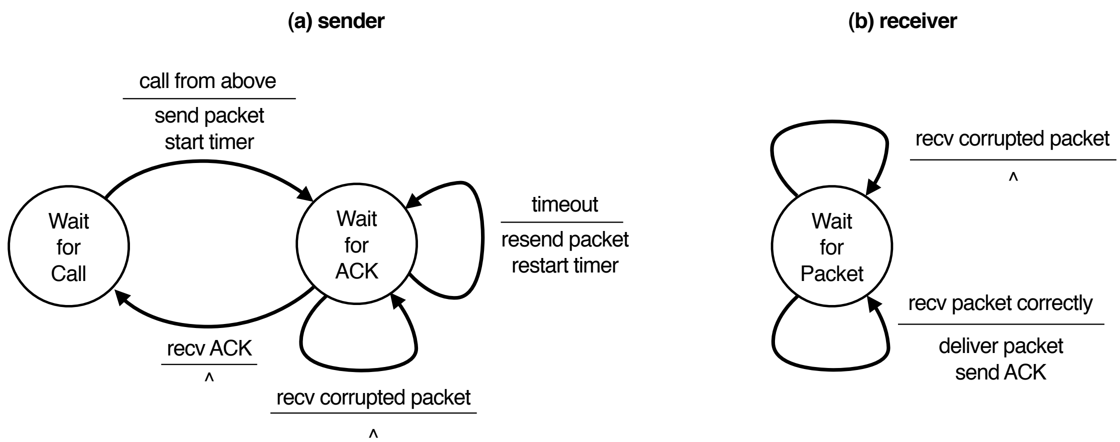

Figure 1: Finite State Machine of a Protocol

(a) (2 points) Is it possible for this protocol to deliver the same packet twice to the application?

Either give an example where the same packet is delivered twice by drawing a timing diagram, or argue why every packet will only be delivered once.

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(b) (3 points) Is it possible for this protocol to not detect a lost data packet?
Either give an example where a lost packet is not detected by drawing a timing diagram or argue why a packet loss is always detected.

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(c) (2 points) Can we remove only one of the network properties P1, P2, P3 so that the protocol works as intended without modification? Justify your answer.

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15. Two hosts A and B, of distance d m apart, are directly connected with a R bps link. Signals propagate at the speed of s m/s on the link. All data frames have a length of L bits (including header and trailer).

    The hosts communicate with a CSMA protocol, which works as follows: When a host has data to send, it senses the channel. If the channel is idle, it sends the data frame immediately; otherwise, it wait for the channel to be idle and sends the data frame as soon as the channel becomes idle. After the frame transmission is done, the host checks if a collision has occured during transmission. If so, it waits for a random amount of time and tries again.

    (a) (5 points) Consider the scenario where A starts sending a data frame F at time t. We classify the time at B into four periods (not necessary consecutive) with respect to F.

    - A *safe period*, is the period during which if B starts sending a data frame G, G will not collide with F.
    - A *detectable collision period* is the period during which if B starts sending a data frame G, G will collide with F and this collision can be detected at either A or B.
    - An *undetectable collision period* is the period during which if B starts sending a data frame G, G will collide with F and the collision can NOT be detected by A nor B.
    - A *busy period* is the period during which B senses that the channel is busy and refrains from sending.

    Draw a timing diagram for A and B and label these four periods at B clearly. Express the boundary of these periods in terms of t, d, R, L, and s.

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    (b) (2 points) What is the minimum value of L, such that a collision is always detected?

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This CSMA scheme does not detect collision. The whole frame is transmitted despite collision, and valuable channel time is wasted. To mitigate this, it is suggested that an RTS (request-to-send) scheme is used. When a node wants to transmit a data frame, it first transmits a small control packet called RTS. The transmission of RTS follows the same algorithm as transmission of data frame. After the RTS is successfully sent, the transmitting node sends the data frame immediately. The other node, upon receiving the RTS, refrains from transmission until it receives the data frame completely.

(c) (1 point) Does the RTS scheme above eliminate collision of data frame completely? Why or why not?

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(d) (1 point) Give a major drawback of using the RTS scheme above.

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(e) (2 points) Give two scenarios where the RTS scheme above is still benefitial.

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END OF PAPER