University of Toronto Mississauga

Midterm Test

Course: CSC358H5 Winter 2020

Section: LEC0101, Larry Zhang

Duration: 90 minutes

Aids allowed: one double-sided 8.5x11 aid sheet

Last Name: ____

Given Name(s): ____

Student Number: ____

Flip to the back cover and write down your name and student number.

This midterm consists of a total of 70 marks, for 6 questions on 12 pages (including this one). When you receive the signal to start, please make sure that your copy is complete.

Each question is labelled with the suggested amount of time that you should spend on it. You may use it as a reference to better manage your time.

Precise answers will be given higher marks than vague ones. Concise answers will be given higher marks than lengthy ones. Illegible answers will not be given marks.

If you write an answer on a page for rough works, indicate clearly what you want to be marked.

Do NOT discuss the test questions before Thursday, Feb 27, 2020, 3:00 PM, with anyone, anywhere online or offline, as it may constitute an academic offence.

You know more than you think you do!

Question 1: Short Answers [36 marks] **[20 minutes]**

For multiple-choice questions, a mark will be deducted for each missing or wrong choice made.

1. Which of the following is better at handling bursty traffic? [2 marks]

   a. circuit switching
   b. packet switching

2. Which one of the following is FALSE about the structure of the Internet? [2 marks]

   a. Access networks are typically directly connected to each other
   b. Access networks are typically connected to ISPs
   c. IXPs connect ISPs
   d. IXPs connect CDNs and ISPs

3. Which of the following is irrelevant for queueing delay? [2 marks]

   a. bandwidth of link
   b. length of link
   c. packet size
   d. packet arrival rate

4. Which transport-layer protocol is used by SMTP? Write the name below. [2 marks]

5. Describe one advantage and one disadvantage of using web caches. Be concise. [4 marks]

   advantage: ____

   disadvantage: ____

6. In which of the following scenarios can P2P have a significant advantage (in terms of file distribution) compared to a client-server architecture. Circle one of the following. [2 marks]

   a. when the file server has a very large upload capacity
   b. when the file server has a very small upload capacity
   c. when the file server has a very large download capacity
   d. when the file server has a very small download capacity

7. Compare a **root name server** and a **top-level domain name server**, which one stores a larger amount of data? Circle one of the following and briefly justify your answer. [2 marks]

Circle one: root name server / top-level domain name server

Justification:

8. Name a transport layer protocol that is connectionless. [2 marks]

9. Consider RDT 3.0, which type of error is the **timeout** mechanism designed to handle? [2 marks]

10. Consider RDT 3.0, without the NAK packet, how does the sender know that the receiver received a corrupted packet? Explain concisely. [2 marks]

11. Which of the following is FALSE about Selective Repeat? Circle **all** that apply. [2 marks]

a. The receiver can store multiple packets.
b. Each ACK can acknowledge the receipt of multiple different packets.
c. It allows out-of-order packet arrivals at the receiver.
d. The sender has a sliding window.

12. In TCP Reno/Tahoe, what are the two types of events that indicate a packet loss? Write their names in the blanks below. [4 marks]

(1) ____

(2) ____

13. Which one of the following is the reason why a **3-way handshake** is necessary when establishing a TCP connection? Circle one of the following. [2 marks]

a. the client may terminate anytime
b. the server may terminate anytime
c. the client's request packet may be lost anytime
d. the server's response packet may be lost anytime

14. How many unique IP addresses are there in the hypothetical subnet **108.148.207.236/22** ? Write the number below. [2 marks]

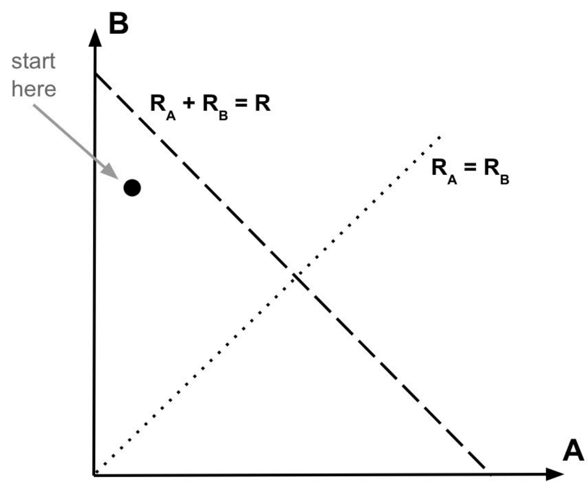
15. In DHCP, how could a newly joined client send a request message to the DHCP server without knowing the server's IP address? Write your answer in **one word**. [2 marks]

16. Name one feature in IPv4 that is removed in IPv6. [2 marks]

Question 2: TCP Fairness [6 marks] **[5 minutes]**

Below is the diagram that we used to illustrate the fairness of AIMD, between two TCP connections A and B sharing the same link with bandwidth R. Now considering the following variation of AIMD named **AIFD (additive increase, fast decrease)**: the **additive increase** is the same as in the original AIMD, i.e., both A and B increases their window sizes linearly with a rate of 1 segment per transmission round; when a packet loss is detected, both A and B immediately reduce their window size to a **constant** of 1 segment (a very small value compared to R). Answer the following questions.

(a) In the following diagram, starting from the black dot, illustrate the change of the bandwidth allocated to A and B and where the allocation converges. [2 marks]



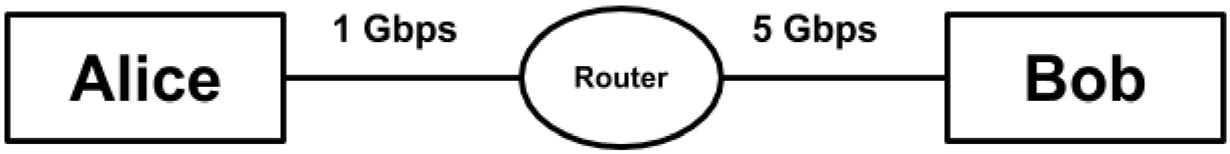
(b) Does AIFD achieve fairness? Circle yes or no, then briefly justify your answer. [2 marks]

Yes / No

(c) Regardless of fairness, what is a **disadvantage** of AIFD compared to AIMD? Be concise. [2 marks]

Question 3: Delay and Throughput [6 marks] **[10 minutes]**

Alice and Bob are connected through a network shown in the following picture. There is a router between them and the bandwidth of Alice's and Bob's links to the router are 1 Gbps and 5 Gbps, respectively. Assume that the propagation speed over the link is **2×10^8** metres/sec.



(a) What is the maximum possible **throughput** from Alice to Bob? [2 marks]

(b) Alice takes a digital photo of her clock and immediately sends it to Bob. Bob receives the photo and notices two things: (1) the size of the photo is **100 Kbits**, and (2) the time when the photo is completely received is **300 microseconds** later than the clock time in the photo. Assume that both Alice and Bob have perfectly accurate clocks. With the information given, calculate the distance between Alice and Bob, i.e., the total length of the two links between them. Write your final answer (in metres) in the blank and show your work in the space below. [4 marks]

Answer: _______________________ metres

Question 4: Go-Back-N [6 marks] **[8 minutes]**

Consider the Go-Back-N protocol with window size 4.

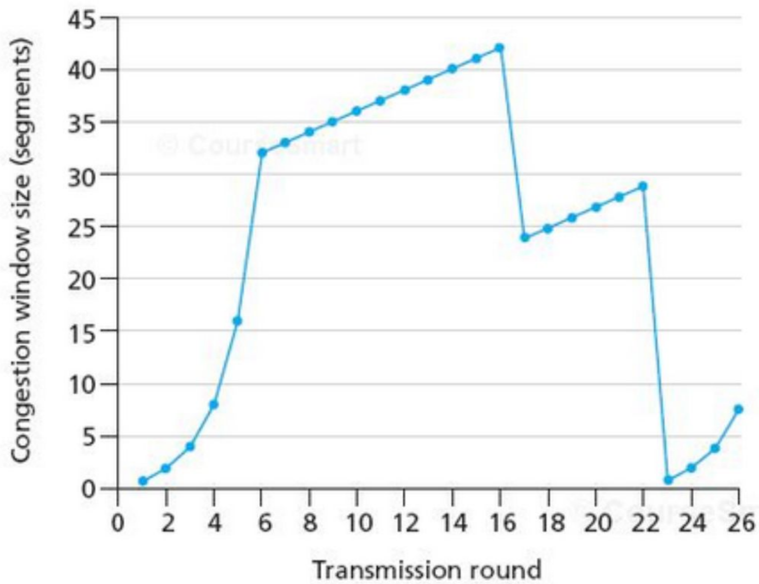
(a) In each row of the following table, indicate the **sender window** (by drawing a rectangle around the appropriate numbers), the **base** and **nextseqnum** variables immediately following the sender event in the first column. The content of the first row is given to you as an example. [4 marks]

Sender Event	Sender Window	base	nextseqnum
send pkt 0	[0 1 2 3] 4 5 6 7 8	0	1
send pkt 1	0 1 2 3 4 5 6 7 8		
send pkt 2	0 1 2 3 4 5 6 7 8		
send pkt 3	0 1 2 3 4 5 6 7 8		
rcv ack 0, send pkt 4	0 1 2 3 4 5 6 7 8		
rcv ack 1, send pkt 5	0 1 2 3 4 5 6 7 8		
rcv ack 1	0 1 2 3 4 5 6 7 8		
rcv ack 1	0 1 2 3 4 5 6 7 8		
pkt 2 timeout	0 1 2 3 4 5 6 7 8		

(b) After the last event, "pkt 2 timeout", which packets are re-sent by the sender? Write below the sequence numbers of the re-sent packets. [2 marks]

Question 5: TCP Congestion Control [8 marks] **[10 minutes]**

Consider the figure below. Assuming TCP Reno is the protocol experiencing the behavior shown in the figure, answer the below questions. **Note**: each dot on the curve is aligned with one transmission round (1, 2, 3, …, 26) on the x-axis -- this will help you locate the x-coordinates of the dots.



(a) Identify **all** intervals of time when TCP **slow start** is operating. Each interval should be written like this: **[starting transmission round, ending transmission round]**, e.g., [3, 8]. [2 marks]

(b) Identify all transmission rounds where a packet loss is detected. Each transmission round should be written as a single integer. [2 marks]

(c) What is the initial value of **ssthresh** at the first transmission round? [2 marks]

(d) During which transmission round is the 70th segment sent? [2 marks]

Question 6: RDT Design for 2-to-1 Transmission [8 marks] **[15 minutes]**

Consider the scenario shown in the above picture: Host A and Host B want to send packets to Host C. Host C, the receiver, must **alternate** in delivering the packets from A and B to the application layer, i.e., it must first deliver a packet from A, then a packet from B, then a packet from A, and so on. You may make the following assumptions:

1. The links AC and BC can lose and corrupt (but not re-order) packets.
2. The senders A and B behave exactly the same as the senders in RDT 3.0, i.e., the stop-and-wait (SAW) protocol that you implemented in Assignment 2.
3. Host C can tell whether a packet is sent from Host A or Host B, and can choose to send an ACK to either Host A or Host B.

Your job is to design the receiver FSM that defines the behaviour of Host C. Answer the following questions.

(a) What are the possible **sequence numbers** that can be received by Host C? [2 marks]

(b) What are the **states** of the FSM at Host C? Provide a short description of what each state represents. Be brief, you don't need to describe all the event triggers and actions at each state. [4 marks]

(c) Does Host C need a **timer**? Briefly explain. [2 marks]

Use the space below for rough work. This page will not be marked,
unless you clearly indicate the part of your work that you want us to mark.

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unless you clearly indicate the part of your work that you want us to mark.

Last Name: ____

Given Name: ____

Student Number: ______________________________________

Q1:	__________	/ 36
Q2:	__________	/ 6
Q3:	__________	/ 6
Q4:	__________	/ 6
Q5:	__________	/ 8
Q6:	__________	/ 8
TOTAL:	__________	/ 70

END OF TEST