

NAME:

Login name:

Computer Science 461
Midterm Exam
March 15, 2013

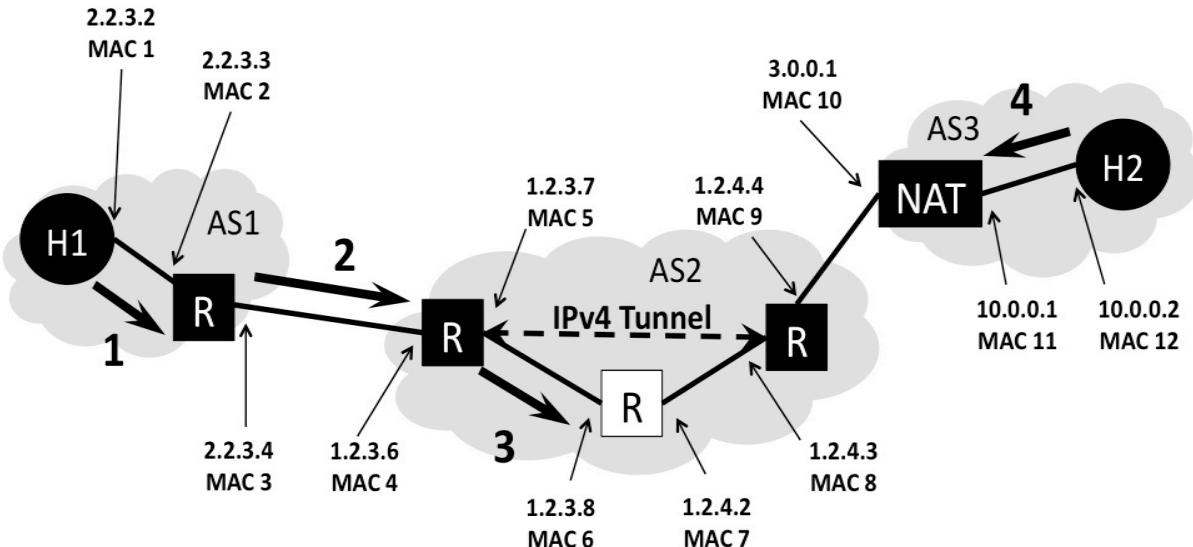
This test has five (5) questions. Put your login name on *every page*, and write out and sign the Honor Code pledge (in cursive) before turning in the test.

The exam will be scored out of 50 points and will last for 50 minutes, so pace yourself. For the few questions that are not multiple choice, show your work.

"I pledge my honor that I have not violated the Honor Code during this examination."

Question	Score
1	/09
2	/10
3	/08
4	/05
5	/18
Total	/50

QUESTION 1: Routing, addressing, and tunneling (9 points)



The above figure shows an Internet topology with three Autonomous Systems (AS). The LAN on the left includes a host H1. The LAN on the right uses a NAT and includes a host H2. Packets between the two endpoints are routed along the path shown, which includes an IPv4 tunnel. The various network interfaces have IP and MAC addresses as shown. Border routers are filled with solid black, interior routers in white.

H1 and H2 have established a TCP connection and data packet 1, 2, 3, and 4 are flowing between the two machines as part of that connection. We have partially filled in the headers for packet 1 (traveling from the H1 to H2) below. Note that you should order your headers from “outermost” in, as shown: Ethernet should be listed before IP, because the Ethernet packet exists first on the wire.

In the following questions, you should fill in the header types, as well as the source and destination address for the network and datalink layer headers. Note: You might not need to use all the rows supplied.

1. Header for packet 1: **Grading: 1/3 for each correct entry: total 7 points**

Header Type	Source	Destination
Ethernet	MAC 1	MAC 2
IP	2.2.3.2	3.0.0.1

2. Header for packet 2:

<i>Header Type</i>	<i>Source</i>	<i>Destination</i>
Ethernet	MAC 3	MAC 4
IP	2.2.3.2	3.0.0.1

3. Header for packet 3:

<i>Header Type</i>	<i>Source</i>	<i>Destination</i>
Ethernet	MAC 5	MAC 6
IP	1.2.3.7	1.2.4.4
IP	2.2.3.2	3.0.0.1

4. Header for packet 4:

<i>Header Type</i>	<i>Source</i>	<i>Destination</i>
Ethernet	MAC 12	MAC 11
IP	10.0.0.2	2.2.3.2

5. In the above figure, AS1 has the IP prefix 2.2.3.0/24, AS2 has 1.2.0.0/16, and AS3 has 3.0.0.0/24. Which of the following are true? Circle **ALL** that apply.

- a. **AS2 could announce prefix 1.2.0.0/16 to AS1 and AS3.**
- b. **AS2 could announce prefix 3.0.0.0/24 to AS1**
- c. If the ASes communicate via BGP, the routing announcements between these ASes will use a distance vector protocol.
- d. **If AS2 was connected to AS4 (not shown in figure) at both of its border routers, it might announce prefix 1.2.3.0/24 via one router and 1.2.4.0/24 via its other router.**

QUESTION 2 : TCP and Congestion Control (11 points)

1. For new TCP connections, sequence numbers always start at 0. Circle ONE.

True or **False**

2. Jack sends Jill a TCP packet containing a 2 byte payload with sequence number 100. If Jill receives it, with what acknowledgement number does she reply?
 - a. 99
 - b. 100
 - c. 101
 - d. **102**
 - e. 103

Billy and Susie are communicating via a new-fangled protocol on a 100kbps link.

The protocol is identical to TCP, except it uses extra-large packets: the protocol's maximum segment size (MSS) is 9 kilobits and its packet headers are 1 kilobit. The round trip time (RTT) on the link is 50ms. Assume ACK packets consist only of header, so they are 1 kilobit in size.

The connection between them is currently in the slow-start phase. At time T, Billy finishes receiving the ACK for the last packet of his previous congestion window of 2 MSS, and simultaneously starts sending his next congestion window's worth of data. Assume that Billy's sender queue has enough data to send out a full congestion window (without waiting on the sending application).

3. At what time will Billy **finish** receiving the ACK for the last packet of his new congestion window? (Explain answer; partial credit given)

400 ms to send + 25 ms to propagate

reverse: 10 ms to send one ack + 25 ms to propagate = 460 ms

4. If at some point further on in Billy's transfer his congestion window is size 8 and he receives no acknowledgements for packets sent within his timeout threshold, what should be the new size of his congestion window? Circle ONE.
- a. 1
 - b. 4
 - c. 7
 - d. 8

5. After changing to the new congestion window size, he will begin by increasing his sending rate. Circle ONE.

Exponentially or **Linearly**

6. This rate of growth will necessarily continue until another packet loss occurs.

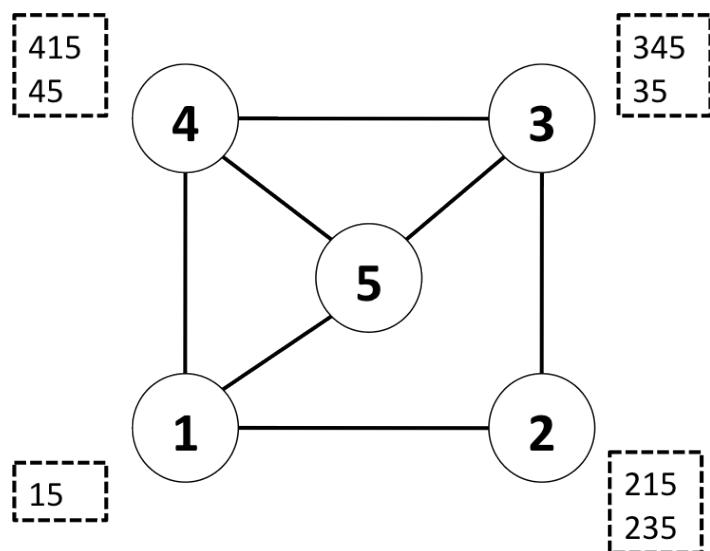
True or **False**

7. Assume the same starting congestion window as Q5 (8 MSS), and that the sequence number for the first packet of the window is 84. If Billy subsequently receives three packets with the ACK flag set and the acknowledgement number as 85, what should Billy's new congestion window size

- a. 1
- b. 4**
- c. 7
- d. 8

QUESTION 3: Routing Convergence (10 points)

1. The below figure shows a network topology, which each vertex representing an Autonomous System (AS). ASes are announcing and withdrawing paths via BGP, and their path preferences are shown in the dashed box next to each vertex. Preferred policies are listed at the top of each list, less preferred policies are at the bottom.

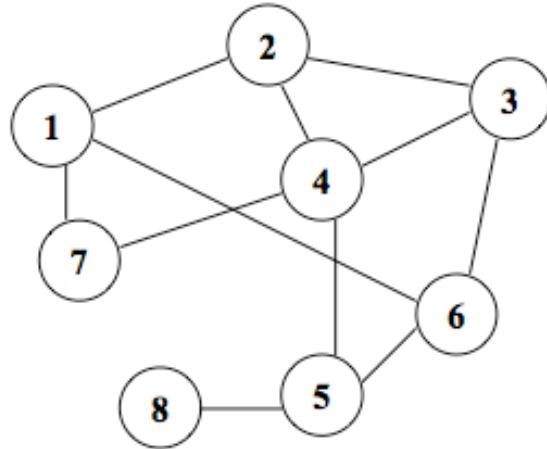


Does this AS topology have a stable paths solution? If yes, give the preferred routes at each node that form the solution (you can draw on the figure). If not, show why. (4 points)

YES

**1 -> 5
2 -> 1 -> 5
4 -> 1 -> 5
3 -> 5**

2. Consider the switched Ethernet topology with eight Ethernet switches shown below. The Ethernet switches use the spanning tree protocol. They switch off ports so as to create a spanning tree with switch "1" as the root of the tree.



- a. Assume that all the Ethernet switches are powered on at exactly the same time, and exchange a message with each other every 5 seconds. How long before every switch knows that switch "1" is the root of the tree? Explain your answer. (2 points)

15 seconds

- b. If a host connected to switch "8" sends a packet to a host connected to switch "7", which switches does the packet pass through on its way? (2 points)

8 -> 5 -> 6 -> 1 -> 7

QUESTION 4: UNIX programming (5 points)

We now test some of your knowledge of UNIX socket programming. For the following questions, be specific, but you don't need to be prolific. Recall the web proxy you implemented for assignment 1.

Your proxy is downloading a web object from an origin webserver through an open TCP connection. When you attempt to read from the socket,

```
char buf[1000];
result = read (socket, buf, 1000);
```

- a. (2 points) If `result` is set to 1000 when the `read` system call returns, what can you conclude about how much data the origin server has already sent your proxy?

>= 1000

- b. (1 point) If a second call to `read` returns 0, what network event likely occurred to cause this? (Be brief and specific)

remote side sent close()

- c. (2 points) Consider if instead of a buffer of 1000 bytes, you use a buffer of 1MB. You notice, however, that any time your proxy does a read (even when speaking with different webservers), it **never** gets a result largely than 10KB. What's the likely cause of this?

OS buffer had maximum size of 10K

QUESTION 5: Multiple choice (18 points)

In the following multiple choice questions, **circle ALL that are true or apply**. A correct answer for each multiple choice option is worth 0.5 points (i.e., a question with options (a) through (e) is worth a total of 2.5 points).

1. Which situation(s) would be better suited to TCP than UDP?
 - a. Instant messaging
 - b. Online banking
 - c. Video chatting via an application like Skype or Google Hangout
2. When a TCP data packet arrives at a host, the operating system's network stack uses the following fields to direct the segment to the appropriate socket:
 - a. Transport protocol number (i.e., "TCP" or "UDP")
 - b. Destination IP address
 - c. Source port number
 - d. Destination MAC address
3. Which of the following statements is/are true about link-layer protocols?
 - a. Link-layer protocols like Ethernet physically encode a single "1" bit using high line voltage and a "0" bit using low line voltage.
 - b. An Ethernet adapter passes every non-corrupt frame that it receives up to the network layer.
 - c. When many hosts seek to actively communicate, token-ring schemes can achieve higher total goodput on a shared LAN than Ethernet.
 - d. When a network is being primarily used by a single host, Ethernet achieves higher goodput than TDMA protocols.
 - e. Ethernet switches learn which MAC addresses are connected to each physical port so it can answer ARP requests.
 - f. Switched Ethernet scales better than non-switched Ethernet because it **only** needs to broadcast those Ethernet frames explicitly sent to the MAC broadcast address (FF:FF:FF:FF:FF:FF), such as ARP requests.

4. Which of the following are true about queue management and scheduling policies in routers? Unless otherwise specified, assume the switch uses FIFO scheduling and a single queue.
- A large flow can more easily consume all the queue space in a drop-tail queue than in one using random-early detection (RED).**
 - Both drop-tail and ECN always drop packets in order to signal congestion.
 - Setting RED's min-threshold close to 0 achieves better goodput when traffic is bursty.
 - Using TCP with drop-tail can lead to poor goodput, as senders may experience synchronized backoff.**
 - Strict priority scheduling can lead to one flow consuming the entire output rate of a router link.**
 - Fair queuing protocols try to ensure that each flow (or class of flows) gets to send an equal number of packets.
5. Which of the following are true:
- An application calling `recv` on a TCP socket will never get data out of order from the network.**
 - Ethernet allows for organizations to route traffic hierarchically to end hosts.
 - Ethernet switches, like IP routers, use a form of forwarding table to determine which output links to send a packet.**
 - In addition to packet forwarding, routers decrement the TTL field in the IP header.**
 - The BGP protocol exchanges link weights.
 - Congestion control prevents overwhelming buffers in the network, while flow control prevents overwhelming the receiver's buffers.**
 - Link-state routing has each router keep $O(n)$ state, where n is the number of routers in the network.
 - Distance vector routing with poison reverse always avoids the "count-to-infinity" problem inherent to distance vector.

6. Using the Gao-Rexford BGP routing rules, which of the following are true:
- a. **AS1 will advertise to its customer the paths that AS1 learned from its provider.**
 - b. AS1 will advertise to its peer the paths that AS1 learned from its provider.
 - c. **AS1 will advertise to its peer the paths that AS1 learned from its customer.**
 - d. **AS1 will advertise to its provider the paths that AS1 learned from its customer.**
 - e. AS1 will advertise to its peer AS2 the paths that AS1 learned from its peer AS3.
7. Which of the following about multicast and anycast is/are true?
- a. Both IP multicast and anycast require special support from routers
 - b. IP anycast can easily use TCP as a transport protocol to achieve reliability.
 - c. Reliable IP multicast protocols typically use ACKs to confirm receipt of data.
 - d. **Reliable multicast protocols can recover from missing data by having parties other than the original sender retransmit the data.**