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STUDENT #:		SIGNATURE:	

UNIVERSITY OF TORONTO MISSISSAUGA
APRIL 2017 FINAL EXAMINATION
CSC358H5S
Principles of Computer Networks
Joe Lim
Duration - 3 hours
Aids: Non-Programmable Calculators; 1 page(s) of double-sided Letter (8-1/2 x 11) sheet

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*Please note, once this exam has begun, you **CANNOT** re-write it.*

Multiple Choice (1-10)	/16
Short Answers (11-16)	/14
Longer Answers	
17	/5
18	/6
19	/2
20	/6
21	/6
TOTAL	/55

Part 1. Multiple Choice. Circle ALL correct answers. 0.5 marks are deducted for every wrong answers given beyond the correct answers. [16/16]

1. Which best describes the Ethernet protocol?
   (a) Talk only if you hear no one else talking, but stop as soon as you hear anybody else.
   (b) Pass a ticket around and only talk if you are holding the ticket.
   (c) Raise your hand and wait till a moderator gives you permission to talk.
   (d) Every person is scheduled a time to talk.
2. TCP guarantees fairness between:
   (a) Flows
   (b) Applications
   (c) End hosts
   (d) Autonomous systems
3. Otto Pilot built a home-brew network with 20 computers. The RTT between each computer is 10 ms. Communication between computers uses a simple UDP query and response protocol. If no response is received within 20 ms, a computer retransmits the request. Soon, Otto notices congestion collapse in his network. Which of the following techniques is/are guaranteed to prevent congestion collapse?
   (a) Double the timeout value from 20 ms to 40 ms.
   (b) Increase the size of the queue in each router from 4 packets to 8 packets.
   (c) Use exponential backoff in the timeout mechanism while retrying queries.
   (d) If a query is not answered within a timeout interval, multiplicatively reduce the maximum rate at which the client application sends query packets.
4. Which of the following is/are true about wireless networks?
   (a) All wireless networks must use access points.
   (b) The sender can always detect a collision without feedback from receiver.
   (c) Collisions are minimized when RTS/CTS mechanisms are used.
   (d) TCP congestion control mechanisms work poorly in wireless environments if they do not perform any type of link-layer retransmission.

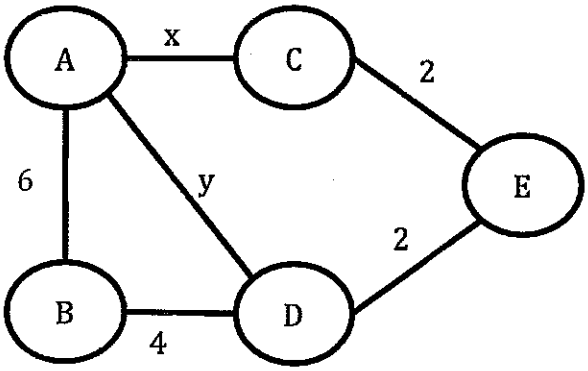
5. When a TCP segment belonging to an existing connection arrives at a host, in order to direct the segment to the appropriate socket the operating system's network stack uses the following fields

(a) the source port number

(b) the destination MAC address

(c) the destination port number

(d) the window size



6. For the above network, which constraints on x and y guarantee traffic from B to C will *always* flow through node A?

(a) $x > 4$

(b) $y + x < 6$

(c) $y + x < 4$

(d) $x < 4$

7. A network advertises the CIDR network number 196.172.56.0/23 (and no other numbers). Which IP addresses could the network own?

(a) 196.172.56.224

(b) 196.172.58.10

(c) 196.172.59.100

(d) 196.172.57.241

8. Which of the following statements are TRUE.

(a) Ethernet switches, like IP routers, use a form of forwarding table to determine which output links to send a packet.

(b) In addition to packet forwarding, routers decrement the TTL field in the IP header.

(c) The BGP protocol exchanges link weights.

(d) Congestion control prevents overwhelming buffers in the network, while flow control prevents overwhelming the receiver's buffers.

9. As packets goes through a router in the Internet, which of the following fields are <u>always</u> modified?

(a) Code bits and sequence number fields of TCP

(b) UDP Source Port and UDP Checksum fields

(c) IP Source Network and Status Fields of EFP

(d) TTL and Checksum fields of IP

10. Which of the following is/are valid IP addresses which may be used to contact remote hosts on the internet?

(a) 127.0.0.0

(b) 222.121.22.2

(c) 221.121.321.421

(d) 137.207.249.99

Part 2. Short Answers. [14/14]

11. BitTorrent does not work well for unpopular files. Why? **[1/1]**

12. Give two reasons that sites use Network Address Translators (NATs). **[2/2]**

13. How does explicit congestion notification (ECN) differ from traditional ways of detecting congestion on Internet paths? Describe one benefit for using ECN and one reason it might not widely be used today. **[3/3]**

14. (a) Suppose Ethernet was the only existing LAN technology, so every host in the Internet was part of a local Ethernet and thus had a globally-unique Ethernet address. Would you recommend getting rid of IP addresses by simply just using Ethernet addresses? Why or why not? **[2/2]**

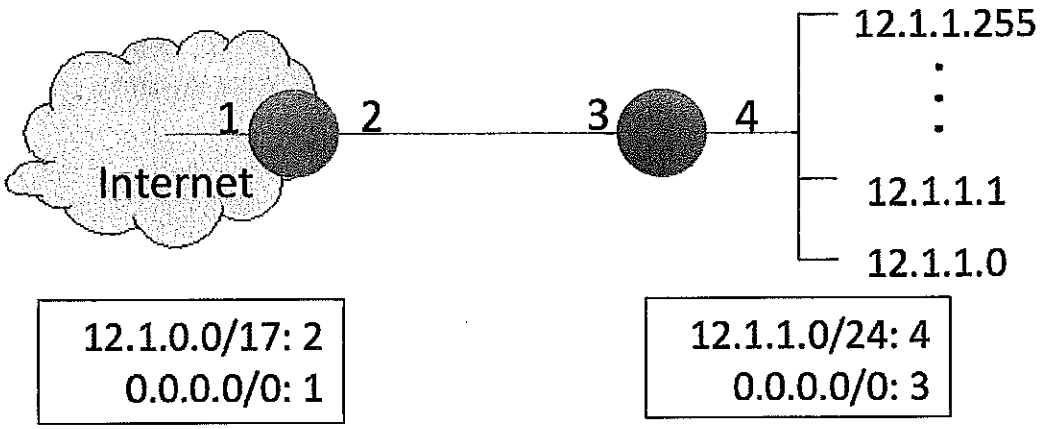
(b) What about the other way around, why do we not simply assign IP addresses to network adaptors, instead of dealing with both Ethernet and IP addresses? **[1/1]**

15. What does it mean for a wireless network to be operating in "infrastructure mode"? If the network is not in infrastructure mode, what mode of operation is it in, and what is the difference between that mode of operation and infrastructure mode? **[3/3]**

16. What are the differences between message confidentiality and message integrity? Can you have confidentiality without integrity or vice-versa? **[2/2]**

Part 3. Longer Answers. [25/25]

17. Defaulting. A small university campus is assigned a large address block 12.1.0.0/17, but is only using a portion of these addresses (in 12.1.1.0/24) to number its computers. The campus uses a single Internet Service Provider (ISP) to reach the rest of the Internet. This picture shows the forwarding tables on the ISP's router (on the left) and the campus edge router (on the right): **[5/5]**



For example, the ISP forwards all packets with destination addresses in 12.1.0.0/17 out link #2 toward the campus edge router. Both routers include a default forwarding entry 0.0.0.0/0 that can match any destination IP address.

(a) How many IP addresses does the campus "own" in its 12.1.0.0/17 block? You can represent your answer as a power of two. **[1/1]**

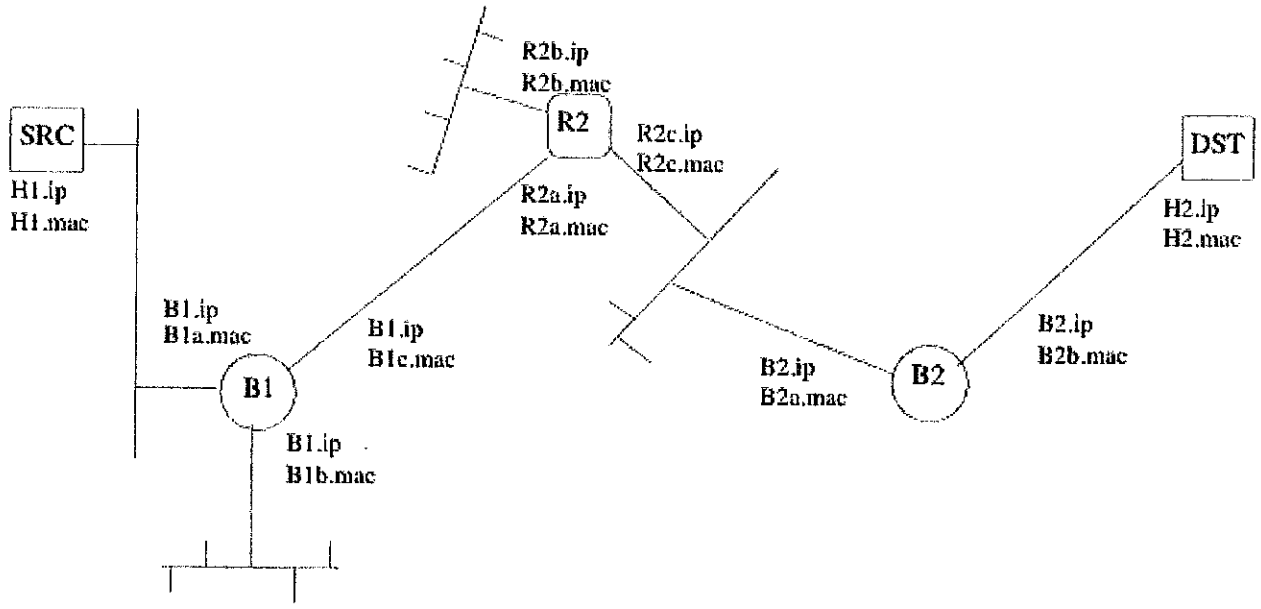
(b) What are the smallest and largest IP addresses that the campus "owns", whether or not the campus is currently using the address? **[1/1]**

(c) Suppose the ISP router receives a packet with destination IP address 12.1.1.1? What path does this packet follow? **[1/1]**

(d) Suppose the ISP router receives a packet with destination IP address 12.1.20.1? What path does this packet follow? **[1/1]**

(e) What ultimately happens to a packet with destination IP address 12.1.20.1? Where does it go? **[1/1]**

18. A Routed and Bridge Network. Below is a picture of a network with 2 bridges and 1 router. Each interface is labeled with both an IP address and a MAC address. Imagine that host H1 (SRC) is sending a packet to host H2 (DST). Answer the following questions: **[6/6]**



a. How many networks are shown above? **[1/1]**

b. Just before the packet reaches bridge B1, what is its layer 2 (Link Layer) destination? **[1/1]**

c. Just before the packet reaches bridge B2, what is its layer 2 (Link Layer) source? **[1/1]**

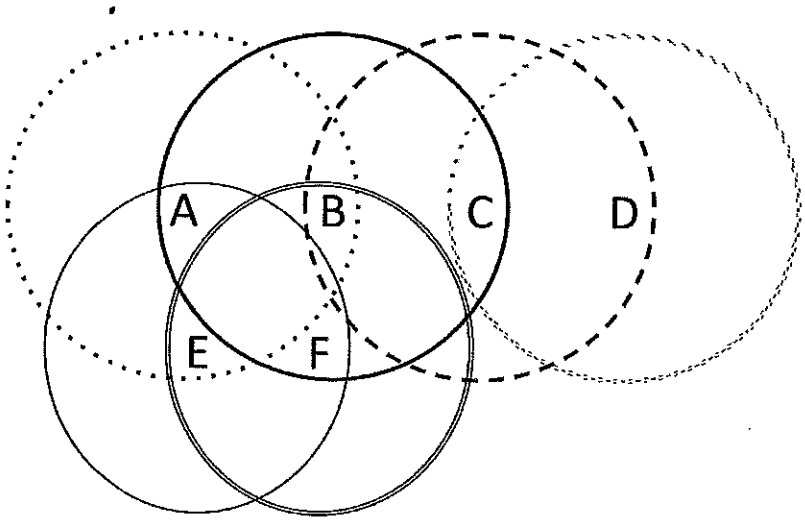
d. Just before the packet leaves router R2, what is its layer 3 source? **[1/1]**

e. When H1 sends out an ARP query, what is the reply to that query? **[1/1]**

f. Does the entry B2a.mac appear in B1's forwarding table? **[1/1]**

19. Forwarding Tables. Suppose we have the forwarding tables shown below for nodes C and D, in a network where all links have cost 1. Give a diagram of the smallest network consistent with these tables. **[2/2]**

NODE C				NODE D		
Node	Cost	Next Hop		Node	Cost	Next Hop
A	2	B		A	1	A
B	1	B		B	2	A
D	3	F		C	3	E
E	2	F		E	1	E
F	1	F		F	2	E



20. Wireless. Consider the wireless topology above, comprised of 6 nodes. Circles around each node illustrate their transmission range, e.g. A's range is shown by the dotted, shaded circle. Assume that if the transmissions of two nodes' will interfere at a location if and only if they transmit at the same time and their transmission areas overlap. In these problems, assume that losses only occur due to collisions. **[6/6]**

(a) When node A transmits to node B, list the potential hidden terminals from A (in either direction, i.e., those who might clobber A's transmission or those who A's transmission might clobber) and exposed terminals. **[2/2]**

a. Hidden Terminals:

b. Exposed Terminals:

(b) What about when node B transmits to node C? **[2/2]**

a. Hidden Terminals:

b. Exposed Terminals:

(c) You are considering using a "Request to Send (RTS)/Clear to Send (CTS)" protocol to reduce these potential problems from hidden and exposed terminals.

a. When using RTS/CTS, explain what would prevent a hidden terminal from clobbering a sender? **[1/1]**

b. When using RTS/CTS, explain how an exposed terminal decides it is safe to send to another destination? **[1/1]**

21. TCP. Suppose your boss calls you up while visiting a client and says he left a 400KB file on a server at the office, and he needs you to send it to him. The connection speed between the office and his current site is 2Mbps. **[6/6]**

(a) Assuming that all bandwidth is consumed by your data (e.g. there aren't any packet headers, there's no other traffic on the link, etc.) and that you can immediately start sending data at the maximum rate, how long will it take to transmit the file? **[1/1]**

(b) Now assume that you are sending the file via TCP, with a maximum segment size of 1000 bytes. You must follow TCP's transport algorithm, so that you start transmitting the file at a low rate. How many network round trip times (RTTs) will it take to transmit the entire file? Again, assume that all bandwidth is consumed by your data. **[1/1]**

(c) Let's now consider how TCP reacts when it encounters packet loss. Your boss now wants you to transmit a graphic file for his presentation. The file size is 1GB. When TCP reaches a transmission rate of 32,000 bytes per second, you notice that a single packet is lost. Assuming that you don't currently have any other packets in transmission, what is the instantaneous rate TCP will send at after noticing the loss? How long (in terms of RTTs) will it take to reach 32,000 bytes per second again? **[2/2]**

(d) In the previous question (c), would anything be different if all packets were lost after you reached 32,000 bytes per second, instead of just a single packet? If so, what is the next transmission rate TCP will send at in this example, and how long (in terms of RTTs) would it now take to reach 32,000 bytes per second again? **[2/2]**