CNT-5008 Final Grading Key

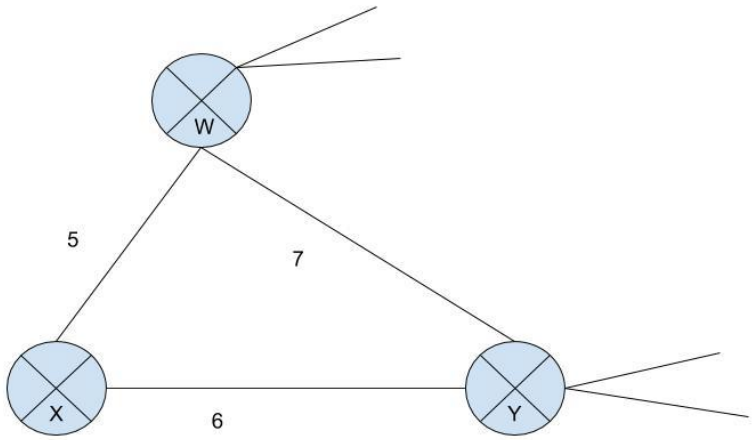
Date: Thursday December 5, 2019

Name: ……

Instructions:

- This exam is open book and open notes. Textbooks and notes on tablet devices are acceptable but they must be put into airplane mode. No device with a keyboard is acceptable.
- It is recommended that you use a pencil, such that you can make corrections. Do not use highlighters, and don't use red colored pens.
- Allotted time is 180 minutes.
- Note that the points add up to 100 + 20 bonus points.

Problem 1 – Distance vectors (20 pts)



See the network fragment above. X has only two attached neighbors, w and y. w has a minimum cost path of 10 to destination u (far away on the internet, not shown in the picture). y has a minimum cost path to u of 8. All the link costs are integer values larger than zero.

a) Give x's distance vector for destinations w, y and u.

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Dx(w) = 5, Dx(y) = 6,  Dx(u) = 14
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b) Give an example of link-cost change for c(x,y) such that x **will inform** its neighbors of a new minimum-cost path to u as a result of executing the distance vector algorithm.

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If c(x,y) gets smaller, eg. c(x,y) = 4, nothing changes
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c) Give an example of a link-cost change for c(x,y) such that x **will not inform** its neighbors of a new minimum-cost path to u as a result of executing the distance vector algorithm.

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If c(x,y) gets bigger than 7, eg c(x,y) = 10, the path through w to u
will be better.
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Problem 2 Link layer general (15 pts)

If all the links on the internet were to provide reliable delivery service, would we still need the TCP reliable delivery service? Why or why not? (3 sentences)

Although each link guarantees that an IP datagram sent over the link will be received at the other end of the link without errors, it is not guaranteed that IP datagrams will arrive at the ultimate destination in the proper order. With IP, datagrams in the same TCP connection can take different routes in the network, and therefore arrive out of order. TCP is still needed to provide the receiving end of the application the byte stream in the correct order. Also, IP can lose packets due to routing loops or equipment failures.

Problem 3: Address spaces (15pts)

a) How big is the MAC address space? How big is the IPv4 address space? How big is the IPv6 address space?

5pts: 2^{48} MAC addresses; 2^{32} IPv4 addresses; 2^{128} IPv6 addresses.

b) Discuss the implications of the above values.

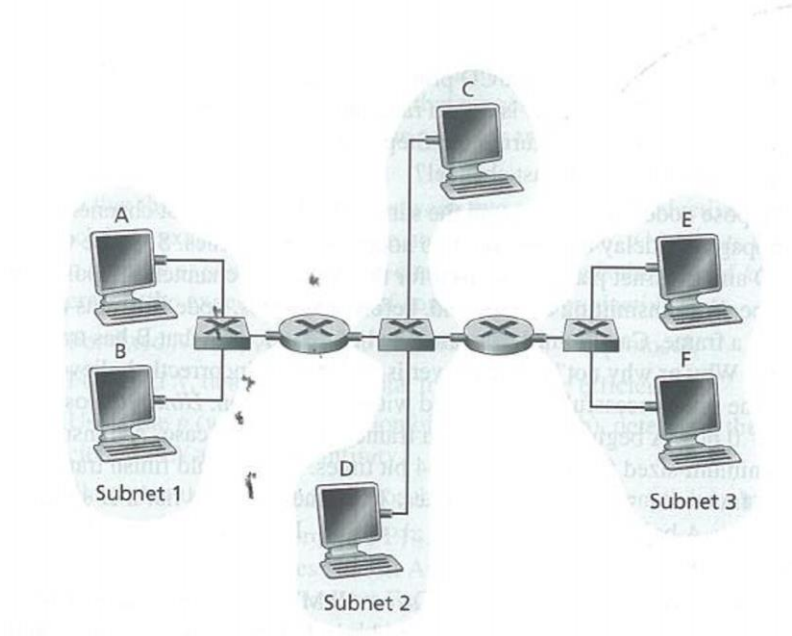
5pts Using IP4 we have more MAC addresses than IP addresses, so we can have unique MAC addresses.
5pts Using IP6, we have way more IP addresses than MAC addresses. We cannot really ensure the uniqueness of MAC addresses if we want to exploit the whole IP address space. But this might not be an issue for a while.

Problem 4: ARP (15pts)

Why is an ARP query sent within a broadcast frame? Why is an ARP response sent within a frame with a specific destination MAC address?

An ARP query is sent in a broadcast frame because the querying host does not which adapter address corresponds to the IP address in question. For the response, the sending node knows the adapter address to which the response should be sent, so there is no need to send a broadcast frame (which would have to be processed by all the other nodes on the LAN).

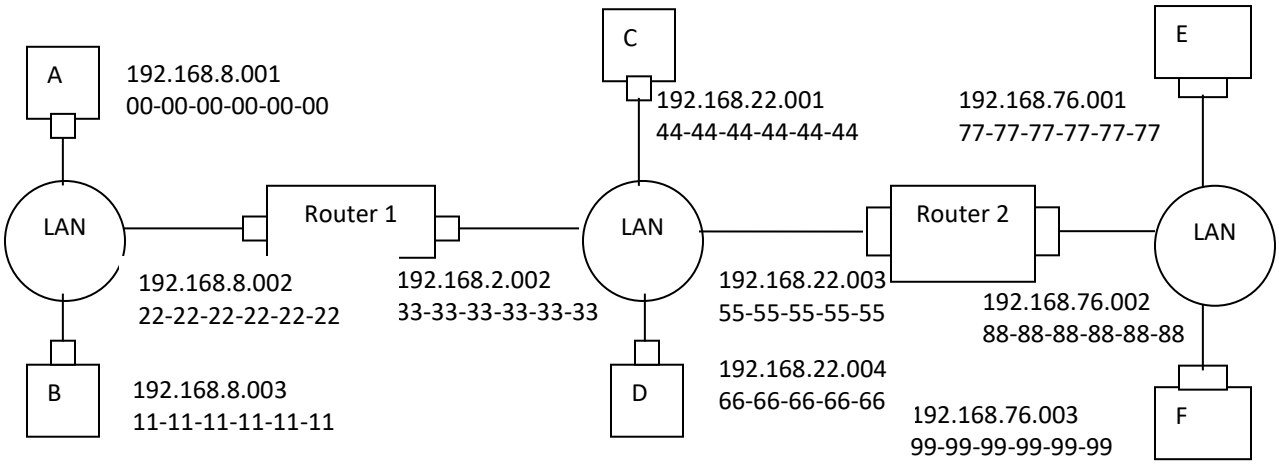
Problem 5: Ethernet (40 pts)



Consider the setup in the figure above (three Ethernet networks interconnected with two routers).

a) Assign IP addresses to all the interfaces. For subnet 1 use addresses of the form 192.168.8.x, for subnet 2, addresses of the form 192.168.22.x, while for subnet 3 addresses of the form 192.168.76.x
b) Assign MAC addresses to all the adapters
c) Consider sending a datagram from Host E to Host B. Suppose all the ARP tables are up to date. Enumerate all the steps.
d) Repeat problem c, assuming that the ARP table in the sending host is empty. All the other tables are up-to-date.
e) Is it possible for A and E to have the same IP address? What about A and B? Discuss in 3 sentences.
f) Is it possible for A and E to have the same MAC address? What about A and B? Discuss in 3 sentences.

a), b) See figure below. 10pts



c) 10 pts
Forwarding table in E determines that the datagram should be routed to interface 192.168.3.002.
The adapter in E creates and Ethernet packet with Ethernet destination address 88-88-88-88-88-88.
Router 2 receives the packet and extracts the datagram. The forwarding table in this router indicates that the datagram is to be routed to 198.162.2.002.
Router 2 then sends the Ethernet packet with the destination address of 33-33-33-33-33-33 and source address of 55-55-55-55-55-55 via its interface with IP address of 198.162.2.003.
The process continues until the packet has reached Host B.

d) 10 pts
ARP in E must now determine the MAC address of 198.162.3.002. Host E sends out an ARP query packet within a broadcast Ethernet frame. Router 2 receives the query packet and sends to Host E an ARP response packet. This ARP response packet is carried by an Ethernet frame with Ethernet destination address 77-77-77-77-77-77.

e) 5pts
A and E can have the same IP address, using NAT. Happens all the time.
A and B cannot have the same IP address.

f) 5pts
With hardwired MAC addresses, normally, it does not happen as they are hardwired to be unique. However, sometimes you can set the MAC address. It should be ok as long as you are not on the same switching domain. If you are, then trouble.

Problem 6: WiFi (15 pts)

a) Explain the similarities between CSMA/CD and CSMA/CA

5pt. They are both MAC protocols, they are both involve carrier sensing, and retransmissions if a collision happened.

b) Which one is more efficient? Discuss.

5pt. CSMA/CD is more efficient, because it does not require RTS, CTS and ACK.

c) Compare the treatment of collisions in CSMA/CD, CSMA/CA and CDMA.

5pt. CD tries to detect the collisions and stop transmitting if detected.

CA tries to avoid the collisions on the main packet and restrict them to small packets.

CDMA allows collisions to happen, but uses the code to extract the original information from the collided frame.