Networks and Distributed Systems CS3700 Fall 2022	Homework 3

This homework is due at 11:59:59 PM on October 24, 2022 and is worth 3% of your grade.

Name: ____

NUID (with leading zeros): ____

Problem	**Possible**	**Score**
1	30	
2	20	
3	10	
4	15	
5	10	
6	5	
7	30	
8	20	
9	10	
Total	150	

1a. What are the main functionalities in IP Addresses. `Hint: There are two.` (5 pts)

1b. What is the Benefit of using IPv6? Give Three Examples of the Improvements. (5 pts)

1c. What happens when an IPv6 packet at the max MTU of one network traverses to a second network with a smaller MTU? (5 pts)

1d. For the following IP addresses, give their class (A, B, or C) and their representation in binary: 129.10.115.10, 4.3.2.129, 220.33.9.21. (5 pts)

1e. The binary representation of `128.42.5.4` is shown below.

```
10000000  00101010  00000101  00000100
```

If the subnet mask is 255.255.248.0, label the bits that correspond to the (a) class prefix, (b) the network number, (c) the subnet number, and (d) the host number. You may assume that class-based IP addressing is being used for this question. (10 pts)

2a. Convert the following IP/subnet representations of networks to the equivalent CIDR representation. If the network cannot be represented in CIDR, briefly explain why.

(i) 128.42.0.0/255.255.0.0

(ii) 192.168.0.0/255.255.224.0

(iii) 172.10.12.0/255.255.253.0

(iv) 64.0.0.0/192.0.0.0 (10 pts)

2b. Suppose that you have been allocated the network `173.98.112.0/20`, and you wish to divide your address space equally into four parts. What are the CIDR (Classless Interdomain Routing) representations of these four parts? (10 pts)

3a. Why does the Offset field in the IP header measure the offset in 8-byte units?
(Hint: Recall that the Offset field is 13 bits long.) (5 pts)

3b. Some signaling errors can cause entire ranges of bits in a packet to be overwritten by all 0s or all 1s. Suppose all the bits in the packet including the Internet checksum are overwritten. Could a packet with all 0s or all 1s be a legal IPv4 packet? (5 pts)

4. Suppose you receive the following series of IP packets at a destination host (be sure to remember that the length field in the packet *includes the header*, and the offset is specified as the number of 8-byte blocks from the beginning of the data in the original IP datagram):

#	ID	Flags	Offset	Total Length
1	0xdb7a	–	370	300
2	0x7823	MF	370	1500
3	0x992a	MF	185	300
4	0x45a9	–	0	1500
5	0x7823	MF	0	1500
6	0x992a	MF	0	1500
7	0xdb7a	MF	185	1500
8	0x9ffb	–	200	1500
9	0xdb7a	MF	0	1500
10	0x33aa	–	0	1500

What packet IDs have you completely received (i.e., all fragments of the original packet have been received), and how many total data bytes are in each of the completely received packets? For this problem, you can assume that all IP packets have no options. (15 pts)

5. You are a router, and one of your outgoing links has an MTU of 1000 bytes (ignore layer 2 headers). You receive the following packets that all need to be sent out over this link:

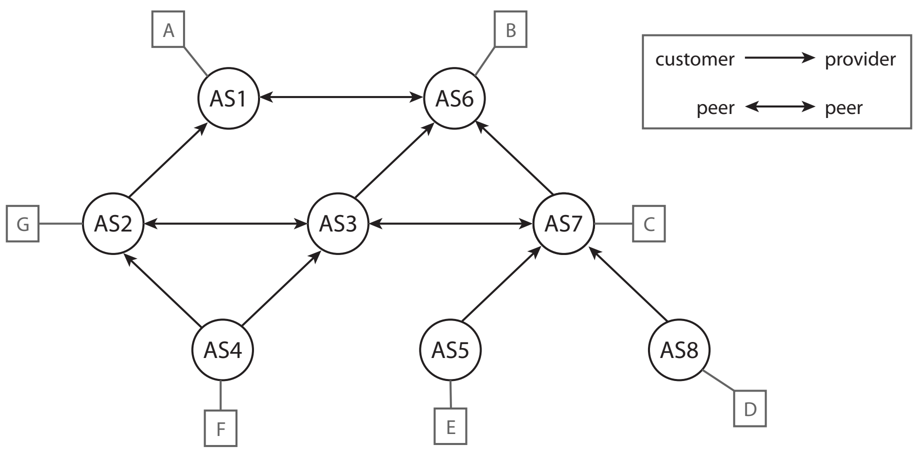
#	ID	Flags	Offset	Total Length
0	0x1930	–	0	1000
1	0x92ad	–	0	3000
2	0x944f	DF	0	1000
3	0xaa22	–	185	1001
4	0x78a1	MF	370	1500
5	0x3ac8	DF	0	1500

Fill in the table below with the header fields of the packets that you send out (you may not need all of the rows). The first packet has been completed for you. (10 pts)

#	ID	Flags	Offset	Total Length
1	0x1930	–	0	1000
2				
3				
4				
5				
6				
7				
8				
9				
10				

6. What are the three main steps that routers that use a distance vector routing protocol (e.g., RIP) perform to keep their routing tables up-to-date? (5 pts)

7. Consider the network shown in the following figure. In the event where an AS has multiple paths to a given destination, assume that it chooses the path with the shortest hop count metric (i.e., the ASes do not have local preferences or other traffic engineering meta-data about routes). In the case where two or more available paths have the same hop count metric, an AS will choose the path through the neighbor with the lowest AS number. `Hint: The key to answering the following questions is thinking about route import and export rules.`

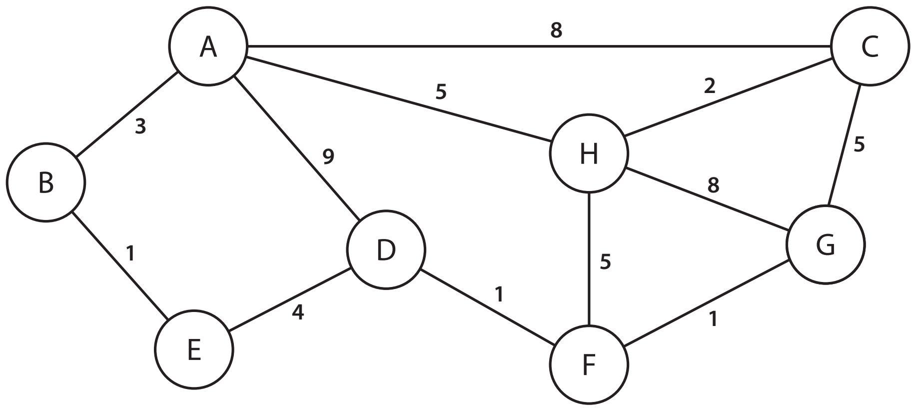


7a. What path would host *F* take to reach host *B*? Explain briefly the routing choice made by each AS based upon the information it has available. (10 pts)

7b. What path would host E take to reach host G? Explain briefly the routing choice made by each AS based upon the information it has available. (10 pts)

7c. All traffic between $AS5$ and $AS8$ must transit through $AS7$. Suppose $AS5$ and $AS8$ want to avoid paying $AS7$ for this service. What could they do to reduce their cost? (10 pts)

8. Consider the networking of routers shown below, with the "link weight" for each link written next to the link:



8a. Use Dijkstra's shortest-path algorithm to compute the shortest path from A to all other routers. Show how the algorithm works by filling out the table on the final page, showing both the current cost to each destination ($D(X)$) and the corresponding shortest path ($p(X)$). (20 pts)

9a. Name one strength distance vector routing has over link state routing. (5 pts)

9b. Name one strength link state routing has over distance vector routing. (5 pts)

Step	**S**	**D(B), p(B)**	**D(C), p(C)**	**D(D), p(D)**	**D(E), p(E)**	**D(F), p(F)**	**D(G), p(G)**	**D(H), p(H)**
1	*A*							
2								
3								
4								
5								
6								
7								
8								