CSE 123: Computer Networks

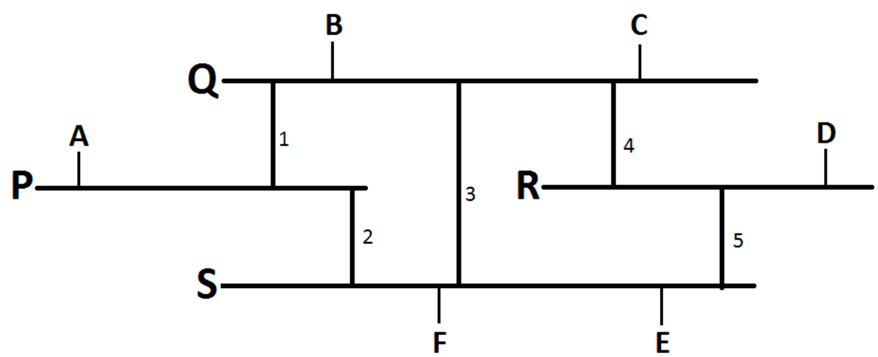
Homework 2

Out: 10/18, Due: 10/25

Total points - 50

Question 1

Consider the network shown below, wherein horizontal lines represent transit providers and numbered vertical lines represent inter-provider links. Assume that networks implement the standard BGP route-selection policy, e.g., preferring shorter AS paths to longer ones.
(6 points in total;0.5 points for each AS path and 0.5 points for each set of links)



a. Suppose that each network adopts a policy that, when choosing among egress links to the next AS, outbound traffic is carried as far possible within the current AS (so-called “cold potato routing”). What route and links would packets traverse if:
    1. A communicates with B
       `<P,Q> across link 1`
    2. E communicates with C
       `<S,Q> across link 3`
    3. D communicates with A
       `<R,Q,P> across links 4 and 1`

b. Now, suppose that each network adopts a policy wherein outbound traffic is routed to the closest link to the next AS in order to minimize the intra-AS cost (so-called “hot potato routing”). What route and links would packets traverse if:
    1. B communicates with D

    <Q,R> across link 4

2. A communicates with F
   `<P,S> across link 2`
3. D communicates with A
   `<R,S,P> across links 5 and 2`

For the purposes of this question, you may mention a route and links in the following format - <ISP 1, ISP 2, ISP 3, ….> across links #, #, ...

Question 2

Suppose a router has the following forwarding table, and that the contents of the router ARP cache are shown below. Describe what the router does (i.e., out of which interface does it forward the packet, and what is the destination MAC address of the outgoing frame) with a packet addressed to each of the following destinations:-
(8 points total; 1 point each for finding next hop interface, 1 point each for finding MAC address of destination)

a. 128.96.39.10
b. 128.96.40.12
c. 128.96.40.151
d. 192.4.153.17

Routing table for R1

Network Name	Netmask	Next Hop
128.96.39.0	255.255.255.128	Interface 0
128.96.39.128	255.255.255.128	Interface 1
192.168.45.0	255.255.255.252	Interface 2
113.89.79.0	255.255.255.252	Interface 3
72.201.65.0	255.255.255.252	Interface 4
128.96.40.0	255.255.255.128	192.168.45.1
192.4.153.0	255.255.255.192	113.89.79.1
<default>	0.0.0.0	72.201.65.1

ARP table for R1

IP Address	MAC Address
128.96.39.10	1C-6E-97-CF-08-DF

128.96.40.12	E9-E7-5E-9A-03-69
128.96.40.151	FD-BC-EE-7A-F1-B3
192.4.153.17	BC-C8-D0-58-3F-E5
192.4.153.90	B8-EF-9C-BA-F8-B5
192.168.45.1	46-F4-93-AF-86-B1
113.89.79.1	FC-01-31-42-FC-60
72.201.65.1	34-74-FC-72-A9-2B
22.231.5.9	75-E1-9B-43-CA-69

Apply each subnet mask on the address and if the subnet number matches any entry in the subnet number entry, then use the entry in the Next Hop column

a. 129.96.39.10 matches 128.96.39.0/25. Hence, the packet goes out on Interface 0 to the destination. ARP resolution on the destination's IP address 128.96.39.10 gives the destination's MAC address 1C-6E-97-CF-08-DF.
b. 128.96.40.12 matches 128.96.40.0/25. The next hop is a router that has an IP address of 192.168.45.1. 192.168.45.1 matches 192.168.45.0/30, which indicates it is on the network attached to interface 2. ARP resolution on the next-hop IP address gives the router's MAC address 46-F4-93-AF-86-B1.
c. 128.96.40.128 matches only the default entry; next hop is a router that has an IP address of 72.201.65.1, which the forwarding table indicates is attached to interface 4. ARP resolution on the router's IP address gives the router's MAC address 34-74-FC-72-A9-2B.
d. 192.4.153.17 matches 192.4.153.0/25; next hop is 113.89.79.1, which is on the network on interface 3. ARP resolution on the next hop's IP address gives the router's MAC address FC-01-31-42-FC-60.

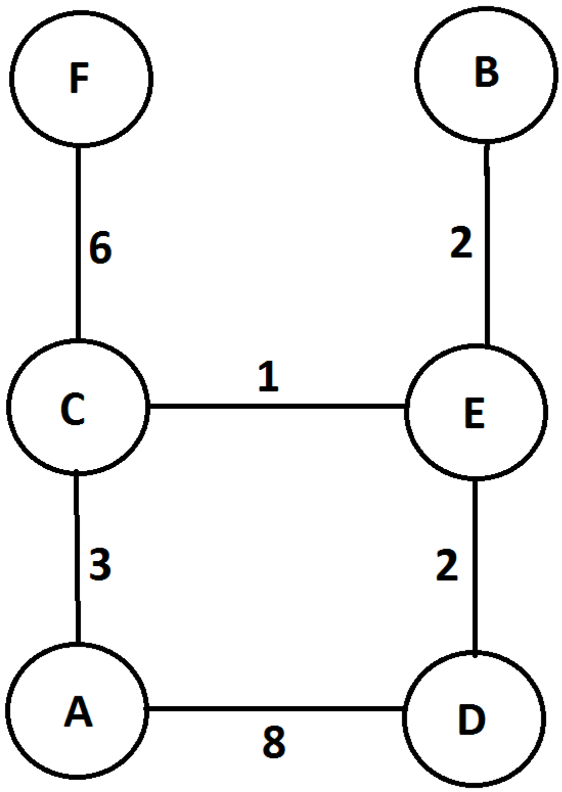
Question 3

For the network shown below, provide a global distance-vector table, indicating the distance from each node to all other nodes, when:-

a. Each node only knows the distances to its immediate neighbors

b. Each node has reported the information it had in the preceding step to its immediate neighbors
c. Step (b) happens a second time

(9 points in total; 0.5 points for each node's distance vector for each table. -0.25 points if 2 entries are wrong, -0.5 point if 3 entries or more are wrong)



a. This is how the table looks initially, when each node only knows the distance to its immediate neighbors

Information stored at each node	**Distance to reach each node**					
	A	**B**	**C**	**D**	**E**	**F**
A	0	inf	3	8	inf	inf
B	inf	0	inf	inf	2	inf
C	3	inf	0	inf	1	6
D	8	inf	inf	0	2	inf
E	inf	2	1	2	0	inf
F	inf	inf	6	inf	inf	0

b. After the nodes report the information from (a) to its neighbors, the table looks like this

Information stored at each node	**Distance to reach each node**					
	A	**B**	**C**	**D**	**E**	**F**
A	0	inf	3	8	4	9
B	inf	0	3	4	2	inf
C	3	3	0	3	1	6
D	8	4	3	0	2	inf
E	4	2	1	2	0	7
F	9	inf	6	inf	7	0

c. After the nodes once again report the information from (b) to its neighbors, the table will look like this

Information stored at each node	**Distance to reach each node**					
	A	**B**	**C**	**D**	**E**	**F**
A	0	6	3	6	4	9
B	6	0	3	4	2	9
C	3	3	0	3	1	6
D	6	4	3	0	2	9
E	4	2	1	2	0	7
F	9	9	6	9	7	0

Question 4

For the same network topology provided in the previous question, state how the link-state algorithm would build the routing table for node D. To start you off, the first entry of the table for

D has been provided below; use this to get to the next step, and the next, and so on, to get the final routing table for D.

(8 points in total; -0.25 points for each wrong entry in each of the columns in each step)

D	Confirmed	Tentative
1	(D,0,-)	

D	**Confirmed**	**Tentative**
1	(D,0,-)	
2	(D,0,-)	(A,8,A) (E,2,E)
3	(D,0,-) (E,2,E)	(A,8,A) (B,4,E) (C,3,E)
4	(D,0,-) (E,2,E) (C,3,E)	(A,6,E) (B,4,E) (F,9,E)
5	(D,0,-) (E,2,E) (C,3,E) (B,4,E)	(A,6,E) (F,9,E)
6	(D,0,-) (E,2,E) (C,3,E) (B,4,E) (A,6,E)	(F,9,E)

7	(D,0,-) (E,2,E) (C,3,E) (B,4,E) (A,6,E) (F,9,E)	

Question 5

Suppose X, Y, and Z are ISPs, that have CIDR allocations 11.0.0.0/8, 12.0.0.0/8, and 13.0.0.0/8 respectively. Assume that each network has only one router and that the hosts on those networks can refer to the router with the network's name. Assume that each provider's customers initially receive address allocations that are a subset of the provider's.

Suppose X has the following customers:-

a. X_a with allocation 11.247.0.0/16
b. X_b with allocation 11.224.0.0/12

And Y has the following customers:-

a. Y_a with allocation 12.29.0.0/20
b. Y_b with allocation 12.28.0.0/20

Then, compute the following:-

1. Give routing tables for Y and Z assuming all providers are connected to each other.
2. Now, if X is only connected to Y and Y is connected to Z, but X and Z are not connected, provide routing tables for X, Y, and Z.
3. Suppose customer X_a acquires a direct link to Y, and Ya acquires a direct link to X, in addition to existing links from part 2 of the question. Provide the routing tables for X and Y.

For the purposes of this problem, you may neglect the default and localhost addresses for the tables. Also, you needn't bother about other local networks the next hop routers/customers are attached to.

To get you started, here's how the table for X will look like when all providers are connected to each other (as given in part 1)

(13 points in total; -0.5 points for each wrong entry in each of the tables)

Address	Next Hop
12.0.0.0/8	Y
13.0.0./8	Z
11.247.0.0/16	X_a
11.224.0.0/12	X_b

1. Y’s table

Address	Next Hop
11.0.0.0/8	X
13.0.0./8	Z
12.29.0.0/20	Y_a
12.28.0.0/20	Y_b

Z’s table

Address	Next Hop
11.0.0.0/8	X
12.0.0./8	Y

2. X’s table

Address	Next Hop
12.0.0.0/8	Y
13.0.0.0/8	Y
11.247.0.0/16	X_a
11.224.0.0/12	X_b

Y’s table will be the same as in part 1

Z’s table

Address	Next Hop
11.0.0.0/8	Y
12.0.0./8	Y

3. X’s table

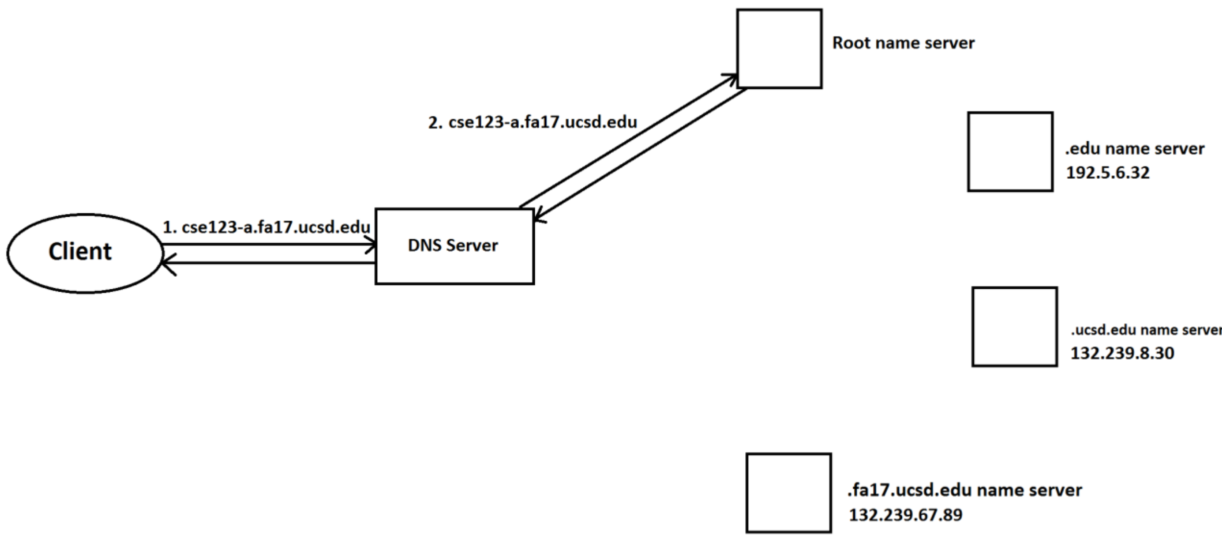
Address	Next Hop
12.0.0.0/8	Y
12.29.0.0/20	Y_a
13.0.0.0/8	Y
11.247.0.0/16	X_a
11.224.0.0/12	X_b

Y’s table

Address	Next Hop
11.0.0.0/8	X
11.247.0.0/16	X_a
13.0.0.0/8	Y
12.29.0.0/20	Y_a
12.28.0.0/20	Y_b

Question 6

Assume we have the following name servers, and the client requests for the IP address resolution of **cse123-a.fa17.ucsd.edu** (not a domain name in the real world, by the way).



What is the reply that the root name server sends to the local DNS server? What are the steps that are then followed in the DNS lookup to get the final address of the specified domain name? Assume that the local DNS server performs a recursive lookup each time on the remainder of the address, and that the IP address for **cse123-a.fa17.ucsd.edu** is 132.239.67.100.
(6 points in total; 0.5 points for IP address and 0.5 points for next name server for each response by name servers, 0.5 points for each request by DNS server, 0.5 points for final response to client)

The following figure shows the sequence of steps followed when querying for the IP address of **cse123-a.fa17.ucsd.edu**