Homework 2 Solutions of CS4550, Summer 2002

1. (10 points) Textbook page 370. Problem 2.

Answer:

A total of 17 paths can be found:

A>B>C>D>E>F
A>B>C>E>F
A>B>C>F
A>B>D>C>E>F
A>B>D>E>F
A>B>D>E>C>F
A>D>B>F
A>D>C>F
A>D>E>F
A>D>E>C>F
A>C>F
A>C>B>D>F
A>C>D>E>F
A>C>E>F

2. (10 points) Textbook page 370. Problem 3.

Answer:

The shortest path computation table is:

step	**N**	D(A),p(A)	D(B),p(B)	D(C),p(C)	D(D),p(D)	D(E),p(E)	D(G),p(G)	D(H),p(H)
0	F	¥	¥	¥	3, F	1, F	6, F	¥
1	F,E	¥	¥	4,E	2,E		6,F	¥
2	F,E,D	¥	11,D	3,D			3,D	¥
3	F,E,D,C	7,C	5,C				3,D	¥
4	F,E,D,C,G	7,C	5,C					17,G
5	F,E,D,C,G,B	6,B						7,B
6	F,E,D,C,G,B,A							7,B
7	F,E,D,C,G,B,A,H							

Shortest paths from F:

to A: F>E>D>C>B>A
to B: F>E>D>C>B
to C: F>E>D>C
to D: F>E>D
to E: F>E
to G: F>E>D>G
to H: F>E>D>C>B>H

3. (10 points) Textbook page 371. Problem 4.

Answer:

The distance table for E is:

$D^E(y, v)$	B	D	C
A	**6**	**13**	**4**
B	**5**	**14**	**5**
D	**9**	**10**	**3**
C	**8**	**11**	**2**

(columns: v; rows: Y)

4. (10 points) Textbook page 371. Problem 5.

Answer:

It is assumed that the algorithm runs synchronously, that is, in one step, all nodes compute their distance tables at the same time and then exchange tables.

At each iteration (step), a node exchanges distance tables with its neighbors. Thus, if you are node A, and your neighbor is B, all of B's neighbors which will all be one or two hops from you will know the shortest cost path of one or two hops to you after one iteration, i.e., after B tells them its cost to you. Let d be the "diameter" of the network, the length of the longest path without loops between any two nodes in the network. Using the reasoning above, after d-1 iterations all nodes will know the shortest path cost of d or fewer hops to all other nodes. Since any path with greater than d hops will have loops and thus have a greater cost than that path with the loops removed, the algorithm will converge in at most d-1 iterations.

Note that it may take more iterations than d-1 for the distance table entries of the nodes to stabilize. But the additional iterations won't change the minimum distance to a destination. So they don't cause additional convergence latency.

5. (10 points) Textbook page 372. Problem 6.

Answer:

(a)

$D^X(y, v)$	W	Y
W	**1**	**?**
Y	**?**	**4**
A	**6**	**10**

(columns: v; rows: Y)

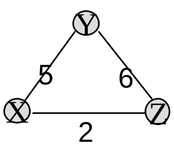
Note that there is not enough information given in the problem (purposefully) to determine the distance table entries D(W,Y) and D(Y,W). To know these values, we would need to know Y's minimum cost to W, and vice versa.

(b) Since X's least cost path to A goes through W, a change in the link cost c(X,W) will cause X to inform its neighbors of a new minimum cost path to A.

(c) Since X's least cost path to A does not go through Y, a change in the link cost c(X,Y) will not cause X to inform its neighbors of a new minimum cost path to A.

6. (10 points) Textbook page 372. Problem 8.

<u>Answer:</u>



After initialization

Via (Destination in rows)

$D^X()$	Y	Z
Y	5	¥
Z	¥	2

$D^Y()$	X	Z
X	5	¥
Z	¥	6

$D^Z()$	X	Y
X	2	¥
Y	¥	6

After first iteration

Via (Destination in rows)

$D^X()$	Y	Z
Y	5	8
Z	11	2

$D^Y()$	X	Z
X	5	8
Z	7	6

$D^Z()$	X	Y
X	2	11
Y	7	6

Since there is no change to minimum distance after the first iteration, the algorithm ends right there.

7. (10 points) Suppose we have the forwarding tables shown in the table below for nodes A and F, in a network where all links have cost 1. Give a diagram of the smallest network (in terms of number of nodes and links) consistent with these tables.

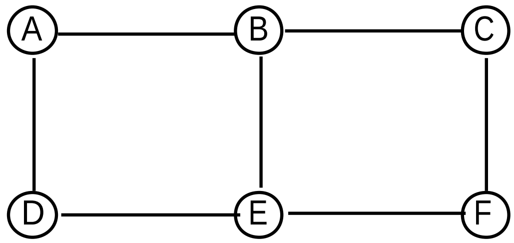
A

Node	Cost	Next hop
B	1	B
C	2	B
D	1	D
E	2	B
F	3	D

F

Node	Cost	Next hop
A	3	E
B	2	C
C	1	C
D	2	E
E	1	E

Answer:



8. (10 points) Suppose a router has built up the routing table shown in table below. The router can deliver packets directly over interfaces 0 and 1, or it can forward packets to routers R2, R3, or R4. Describe what the router does with a packet addressed to each of the following destinations:

(a) 128.96.39.10
(b) 128.96.40.12
(c) 128.96.40.151
(d) 192.4.153.17
(e) 192.4.153.90

SubnetNumber	SubnetMask	Next hop
128.96.39.0	255.255.255.128	Interface 0
128.96.39.128	255.255.255.128	Interface 1
128.96.40.0	255.255.255.128	R2
192.4.153.0	255.255.255.192	R3
<default>		R4

Answer:

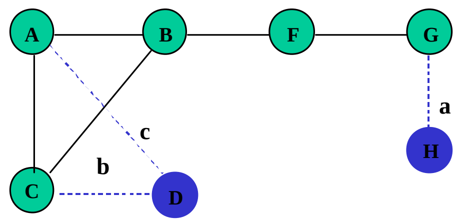
(a) Output to interface 0 (route with MAC address)
(b) Route to R2
(c) Route to R4
(d) Route to R3
(e) Route to R4

9. (10 points) Consider the network in figure below, using link-state routing. Suppose the B-F link fails, and the following events then occur in sequence:

a. Node H is added to the right side with a connection to G.
b. Node D is added to the left side with a connection to C.

c. A new link D-A is added.

The failed B-F link is now restored. Describe what link state packets will flood back and forth. Assume that the initial sequence number at all nodes is 1, and that no packets time out, and that both ends of a link use the same sequence number in their LSP for that link, greater than any sequence number either used before.



<u>Answer:</u>

Each router will buffer a copy of the most recent LSP from every other router. When the link between B and F fails, node B and F flood the network with LSP packet B1 and F1 respectively to report the failure. When node H is added, node G and H report the addition with LSP packet G1 and H1 respectively. At the same time, G delivers all LSPs stored in its buffer to H. When node D is added, node C and D report the addition with LSP packet C1 and D1 respectively. At the same time, C delivers all LSPs stored in its buffer to D. When a new link between D and A is established, node A and D report the addition with LSP packet A1 and D2 respectively. When link B-F is restored, node B and F synchronize their LSP buffers, causing the previous LSPs to be flooded to the part of the network that they have not reached before.

10. (10 points) Textbook page 374. Discussion Problem 1. Explain your answer.

<u>Answer:</u>

No. With BGP alone, an AS may control who can access its network only by advertising paths selectively to neighboring AS's. Since Z has a peering agreement with Y and wants to transit Y's traffic, it must advertise paths to Y. Y has a peering agreement with X, so it's obligated to advertise these paths containing Z --- based on its own polices, not Z's --- to X and carry the resulting traffic. Since a BGP gateway does not filter traffic based on source addresses, there is no way for Z to prevent X's traffic from entering its network via Y.