solution: CS120 Homework Assignment #2

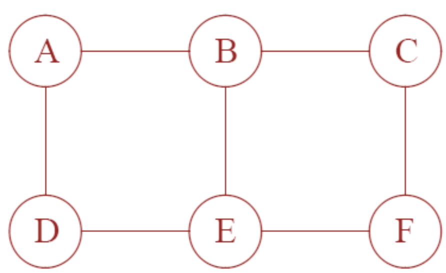
Name: _______________ ID: ____________________

Please read the following instructions carefully before answering the questions:

- This assignment is to be completed by each student **individually**.
- There are a total of **8** questions.
- When you write your answers, please try to be precise and concise.
- Fill your name and student ID at the first page.
- Please typeset the file name and format of your submission to the following one: YourID_CS120_HW2.pdf (Replace "YourID" with your student ID). Submissions with wrong file name or format will **NOT** be graded.
- Submit your homework through Blackboard.

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

Table 1: Forwarding Tables for Exercise 1		
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



2. (10 points) Consider the virtual circuit switches in Figure 1. Table 2 lists, for each switch, what <port, VCI> (or <VCI, interface>) pairs are connected to what other. Connections are bidirectional. List all endpoint-to-endpoint connections.

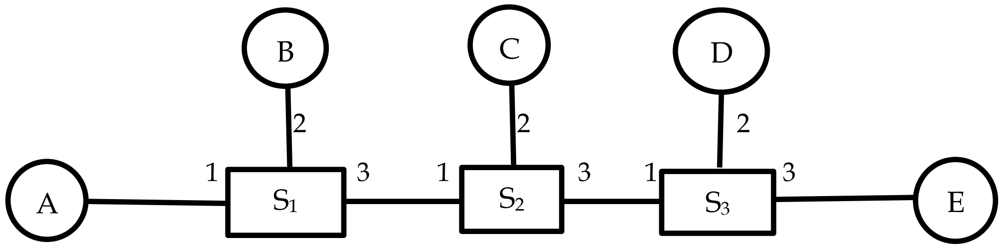


Figure 1

Table 2: VCI Tables for Switches in Figure 1			
Switch S_1			
Port	VCI	Port	VCI
1	2	3	1
1	1	2	3
2	1	3	2
Switch S_2			
Port	VCI	Port	VCI
1	1	3	3
1	2	3	2
Switch S_3			
Port	VCI	Port	VCI
1	3	2	1
1	2	2	2

A connects to D via S1 --- S2 --- S3

A connects to B via S1

B connects to D via S1 --- S2 --- S3

3. (10 points) Consider the arrangement of learning bridges shown in Figure 2. Assuming all are initially empty, give the forwarding tables for each of the bridges B1 to B4 after the following transmissions:

   - A sends to C
   - C sends to A
   - D sends to C

   Identify ports with the unique neighbor reached directly from that port; that is, the ports for B1 are to be labeled "B1_A" and "B1_B2".

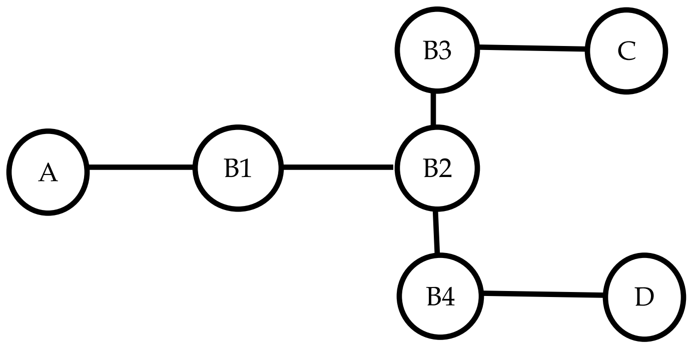


Figure 2

When A sends to C, all bridges see the packet and learn where A is. Similarly, when C sends to D, all bridges see the packet and learn where C is. However, when D then sends to C, the packet is routed directly to C and B1 does not learn where D is.

B1	**B2**	**B3**	**B4**
A, B1_A	A, B2_B1	A, B3_B2	A, B4_B2
C, B1_B2	C, B2_B3	C, B3_C	C, N/A
D, N/A	D, B2_B4	D, B3_B2	D, B4_D

4. (5 points) Suppose a TCP message that contains 1024 bytes of data and 20 bytes of TCP header is passed to IP for delivery across two networks interconnected by a router (i.e., it travels from the source host to a router to the destination host). The first network has an MTU of 1024 bytes; the second has an MTU of 576 bytes. Each network's MTU gives the size of the largest IP datagram that can be carried in a link-layer frame. Give the sizes and offsets of the sequence of fragments delivered to the network layer at the destination host. Assume all IP headers are 20 bytes.

   Consider the first network. An MTU of 1024 means that is the largest IP datagram that can be carried, so a datagram has room for $1024 - 20 = 1004$ bytes of IP-level data; because 1004 is not a multiple of 8, each fragment can contain at most $8 \times \lfloor 1004/8 \rfloor = 1000$ bytes. We need to transfer $1024 + 20 = 1044$ bytes of data when the TCP header is included. This would be fragmented into fragments of size 1000, and 44.

   Over the second network the 44-byte packet would be unfragmented but the 1000-data-byte packet would be fragmented as follows. The 576-byte MTU allows for up to $576-20 = 556$ bytes of payload, so rounding down to a multiple of 8 again allows for 552 bytes in the first fragment with the remaining 448 in the second fragment.

   fragement 1: size 552 bytes, offset 0

   fragement 2: size 448 bytes, offset 552

   fragement 3: size 44 bytes, offset 1000

5. (5 points) Table 3 is a routing table using CIDR. Address bytes are in hexadecimal. The notation "/12" in C4.50.0.0/12 denotes a netmask with 12 leading 1 bits: FF.F0.0.0. Note that the last three entries cover every address and thus serve in lieu of a default route. State to what next hop the following will be delivered

   a) C4.5E.13.87

   b) C4.5E.22.09

   c) C3.41.80.02

   d) 5E.43.91.12

   e) C4.6D.31.2E

Table 3: Routing Table for Exercise 5	
Net/Mask Length	Next hop
C4.50.0.0/12	A
C4.5E.10.0/20	B
C4.60.0.0/12	C
C4.68.0.0/14	D
80.0.0.0/1	E
40.0.0.0/2	F
00.0.0.0/2	G

(a): B

(b): A

(c): E

(d): F

(e): C

6. (20 points) An organization has been assigned the prefix 212.1.1/24 (class C) and wants to form subnets for four departments, with hosts as follows:

A	75 hosts
B	35 hosts
C	20 hosts
D	18 hosts

There are 148 hosts in all.

(a) Give a possible arrangement of subnet masks to make this possible. (10 points)

(b) Suggest what the organization might do if department D grows to 32 hosts (Hint: Give A two subnets). (10 points)

(a) Giving each department a single subnet, the nominal subnet sizes are 2^7, 2^6, 2^5, 2^5 respectively; we obtain these by rounding up to the nearest power of 2. For example, a subnet with 128 addresses is large enough to contain 75 hosts. A possible arrangement of subnet numbers is as follows (NOTE: There are multiple possible solutions).

A: 11010100 00000001 00000001 **0**0000000 - 11010100 00000001 00000001 **0**1111111

Subnet: 212.1.1.0

Mask: 255.255.255.80

B: 11010100 00000001 00000001 **10**000000 - 11010100 00000001 00000001 **10**111111

Subnet: 212.1.1.80

Mask: 255.255.255.C0

C: 11010100 00000001 00000001 **110**00000 - 11010100 00000001 00000001 **110**11111

Subnet: 212.1.1.C0

Mask: 255.255.255.E0

D: 11010100 00000001 00000001 **111**00000 - 11010100 00000001 00000001 **111**11111

Subnet: 212.1.1.E0

Mask: 255.255.255.E0

(b) Give A two subnets, of sizes 64 and 32; every other department gets a single subnet of size the next highest power of 2: A: 2^6+2^5, B: 2^6, C: 2^5, D: 2^5 (NOTE: There are multiple possible solutions)

A: 11010100 00000001 00000001 **00**000000 - 11010100 00000001 00000001 **00**111111

Subnet: 212.1.1.0

Mask: 255.255.255.C0

Plus

11010100 00000001 00000001 **110**00000 - 11010100 00000001 00000001 **110**11111

Subnet: 212.1.1.C0

Mask: 255.255.255.E0

B: 11010100 00000001 00000001 **01**000000 - 11010100 00000001 00000001 **01**111111

Subnet: 212.1.1.40

Mask: 255.255.255.C0

C: 11010100 00000001 00000001 **111**00000 - 11010100 00000001 00000001 **111**11111

Subnet: 212.1.1.E0

Mask: 255.255.255.E0

D: 11010100 00000001 00000001 **10**000000 - 11010100 00000001 00000001 **10**111111

Subnet: 212.1.1.80

Mask: 255.255.255.C0

7. (30 points) For the network shown in Figure 3, give global distance–vector tables like those of Tables 3.10 and 3.13 in textbook (refer to Computer Networks, Fifth Edition) when:

(a) Each node knows only the distances to its immediate neighbors. (10 points)

(b) Each node has reported the information it had in the preceding step to its immediate neighbors. (10 points)

(c) Step (b) happens a second time. (10 points)

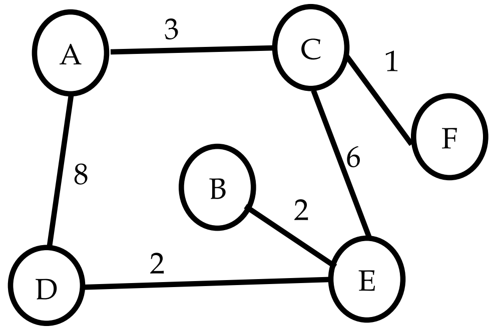


Figure 3

(a)

	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	6	1
D	8	inf	inf	0	2	inf
E	inf	2	6	2	0	inf
F	inf	inf	1	inf	inf	0

(b)

	A	B	C	D	E	F
A	0	inf	3	8	9	4
B	inf	0	8	4	2	inf
C	3	8	0	8	6	1
D	8	4	8	0	2	inf
E	9	2	6	2	0	7
F	4	inf	1	inf	7	0

(c)

	A	B	C	D	E	F
A	0	11	3	8	9	4
B	11	0	8	4	2	9
C	3	8	0	8	6	1
D	8	4	8	0	2	9
E	9	2	6	2	0	7
F	4	9	1	9	7	0

8. (10 points) For the network given in Figure 3, show how the link-state algorithm builds the routing table for node D.

Step	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,8,E)
4.	(D,0,-) (E,2,E) (B,4,E)	(A,8,A) (C,8,E)
5.	(D,0,-) (E,2,E) (B,4,E) (A,8,A)	(C,8,E)
6.	(D,0,-) (E,2,E) (B,4,E) (A,8,A) (C,8,E)	(F,9,E)
7.	(D,0,-) (E,2,E) (B,4,E) (A,8,A) (C,8,E) (F,9,E)	