COMP 4320 Introduction to Computer Networks
Homework Assignment 3 Liam Maher
Due on Sunday, July 21 on Canvas (submit scan of your answer sheet)

Instruction: Every student should finish the following questions independently. Give justification for the results (i.e., show the calculation process) to receive credits.

Finish Questions 1, 3, 13, and 15 in the attached question set and also the following Question 5.

1. Using the example network given in Figure 3.44, give the virtual circuit tables for all the switches after each of the following connections is established. Assume that the sequence of connections is cumulative; that is, the first connection is still up when the second connection is established, and so on. Also assume that the VCI assignment always picks the lowest unused VCI on each link, starting with 0, and that a VCI is consumed for both directions of a virtual circuit.

(a) Host A connects to host C.

Switch	Input port	Input VCI	Output port	Output VCI
1	2	0	3	0

(b) Host D connects to host B.

Switch	Input port	Input VCI	Output port	Output VCI
1	0	0	1	0
2	3	0	0	0
3	0	0	3	0

(c) Host D connects to host I.

Switch	Input port	Input VCI	Output port	Output VCI
1	0	1	1	1
2	3	1	0	1
3	0	1	2	0

(d) Host A connects to host B.

Switch	Input port	Input VCI	Output port	Output VCI
1	2	1	1	2
2	3	2	0	2
3	0	2	3	1

(e) Host F connects to host J.

Switch	Input port	Input VCI	Output port	Output VCI
4	2	0	1	0
2	1	0	0	3
3	0	3	3	0

(f) Host H connects to host A.

Switch	Input port	Input VCI	Output port	Output VCI
4	0	0	3	1
2	1	1	3	0
1	1	3	2	2

3. For the network given in Figure 3.45, give the datagram forwarding table for each node. The links are labeled with relative costs; your tables should forward each packet via the lowest-cost path to its destination.

A:

Destination	Next
A	N/A
B	C
C	C
D	C
E	C
F	C

B:

Destination	Next
A	E
B	N/A
C	E
D	E
E	E
F	E

C:

Destination	Next
A	A
B	E
C	N/A
D	E
E	E
F	F

D:

Destination	Next
A	E
B	E
C	E
D	N/A
E	E
F	E

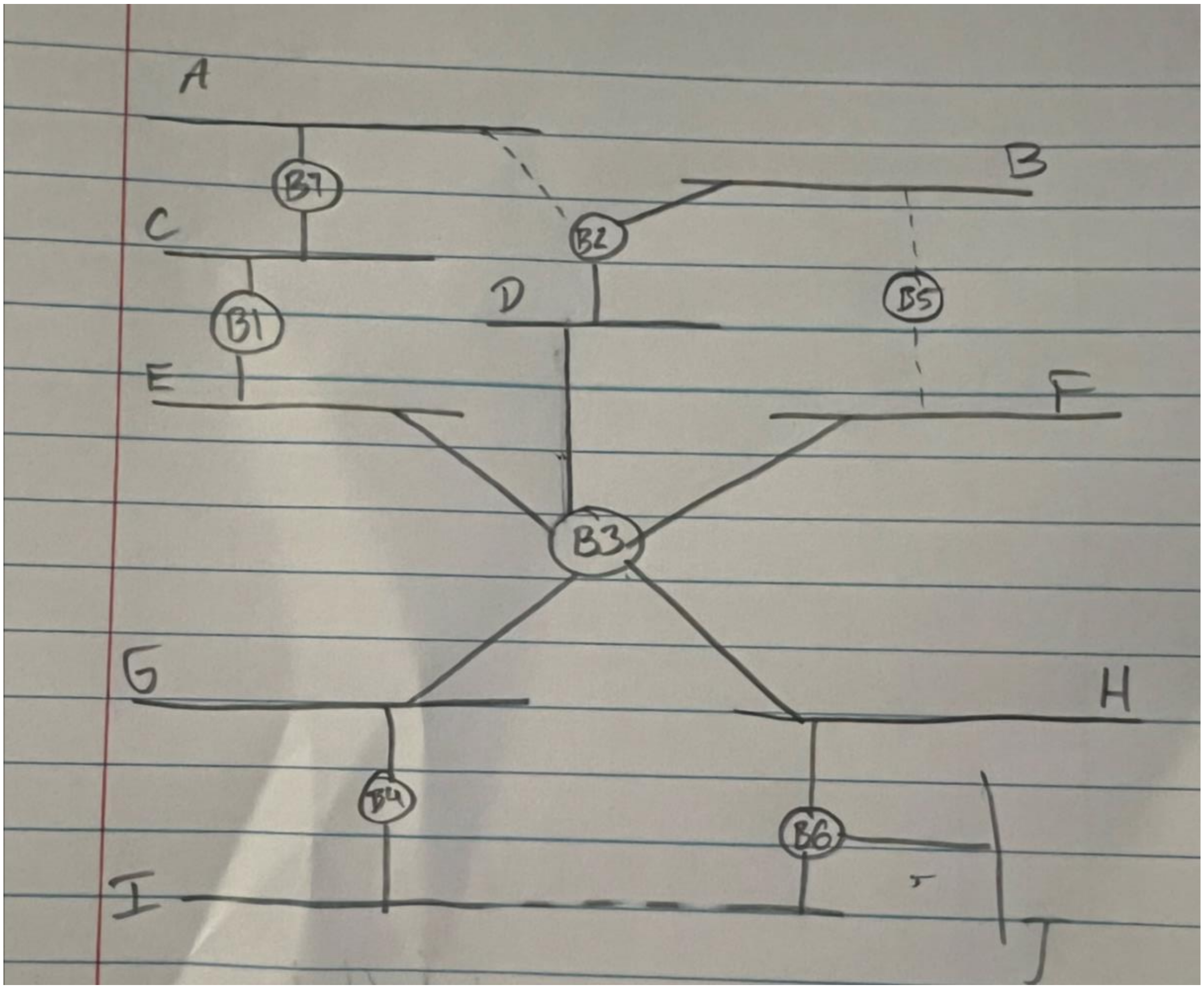
E:

Destination	Next
A	C
B	B
C	C
D	D
E	N/A
F	C

F:

Destination	Next
A	C
B	C
C	C
D	C
E	C
F	N/A

13. Given the extended LAN shown in Figure 3.48, indicate which
ports are not selected by the spanning tree algorithm
Soln: Could not figure out how to make a diagram on word so I uploaded photo below. Dotted lines mean not selected



15. Consider the arrangement of learning bridges shown in
Figure 3.49. 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. = A→B1→B2→B3→C, B4→D

C sends to A. = C→B3→ B2 → B1 → A

D sends to C. = D→ B4 →B2 → B3 → C

Identify ports with the unique neighbor reached directly from that
port; that is, the ports for B1 are to be labeled “A” and “B2.”

B1: A→A, B2→ C

B2: B1→A, B3→C, B4→D

B3: C→C, B2 →A

B4: D→D, B2→A

5. Let A and B be two stations attempting to transmit on an Ethernet. Each has a steady queue of frames ready to send; A's frames will be numbered A1, A2, and so on, and B's similarly. Let T = 51.2 µs be the exponential backoff base unit. Suppose A and B simultaneously attempt to send frame 1, collide, and happen to choose backoff times of 0×T and 1×T, respectively, meaning A wins the race and transmits A1 while B waits. At the end of this transmission, B will attempt to retransmit B1 while A will attempt to transmit A2. These first attempts will collide, but now A backs off for either 0×T or 1×T, while B backs off for time equal to one of 0×T, . . . ,3×T.

a. Give the probability that A wins this second backoff race immediately after this first collision; that is, A's first choice of backoff time k ×51.2 is less than B's.

Soln:

A -> 0xT

A wins if B -> 1xT, 2xT, 3xT

Prob A chooses 0xT = ½

Prob B chooses 1, 2, 3xT = ¾

Prob = ½ * ¾ = 3/8

A -> 1xT

A wins if B-> 2xT, 3xT

Prob A chooses 1xT = ½

Prob B chooses 2, 3xT = 2/4 = ½

Prob = ½ * ½ = ¼

Prob = 3/8 + ¼ = 3/8 + 2/8 = 5/8

b. Suppose A wins this second backoff race, and A transmits A2 successfully. After that, A attempts to transmit A3 while B attempts to retransmit B1 once again. Suppose A and B collide again when they are trying to do the above, so they again have a backoff race. Give the probability that A wins this third backoff race immediately after the first collision.

Soln:

A -> 0xT

A wins if B chooses 1, 2, 3, …, 7xT

Prob A chooses 0xT = ½

Prob B chooses 1, 2, 3, … 7xT = 7/8

Prob = 7/8 * ½ = 7/16

A-> 1xT

A wins if B chooses 2, 3, …, 7xT

Prob A chooses 1xT = ½

Prob B chooses 2, 3, …., 7xT = 6/8

Prob = ½ * 6/8 = 6/16

Prob = 7/16 + 6/16 = 13/16

c. Give a reasonable lower bound for the probability that A wins all the remaining backoff races (i.e., the 4^{th}, 5^{th}, …etc.).

To win, A needs backoff < B backoff →Prob(A Win) = Prob (A backoff < B Backoff)
0→ $2^n - 1$ slots

Prob A win 3rd backoff from b = 13/16

4th backoff: (1/2 * 15/16) + (1/2 * 7/8) = 29/32

Generalize:
A: = 0xT P(a win) = (2^n – 1)/2^n
A = 1xT P(a win) = (2^n – 2)/2^n = 1 – 2/2^n

P(A wins nth race) = (1/2 * (2^n – 1)/2^n) + (1/2 * (1 – 2/2^n) = 1 – 1/(2^(n-1))

$$P(A\ wins\ remaining)\prod_{n=4}^{\infty}(1-1/(2^{n-1}))$$

(typing that out would be redundant so I am typing from 4th to 10th)

= 7/8 * 15/16 * 63/64 * 127/128 * 255/256 * 511/512 ≈ 0.77

d. What will happen to the frame B1 at last if B loses all backoff races?

It will eventually stop trying to transmit B1 and move on to B2.