Final Exam

Spring 2023

CS 5700

Questions: 5

Points Possible: 130

For all questions, your answers must be based on what was taught in class this semester. Anything else will get you points deducted, up to and including zero credit. You must complete this exam individually.

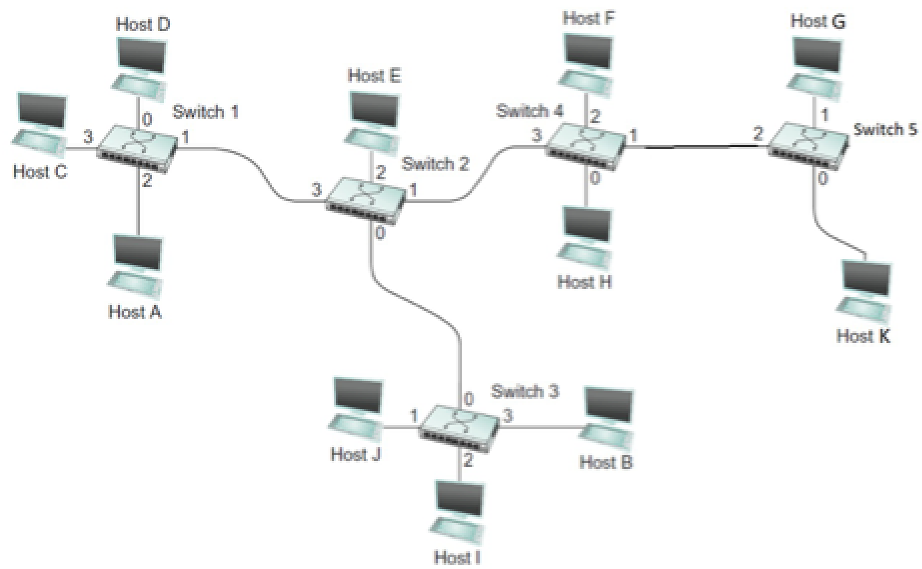
Show as much work as possible to attempt to get partial credit. If the question says to show your work, then show your work, otherwise you will get zero credit.

If you are writing out your answers, I recommend you give yourself about 15 minutes of buffer time to scan your exam and upload/submit it to Canvas. Otherwise, if typing in your answer to the word document, you should still give yourself enough time to save the document and upload/submit it to Canvas.

You must submit your Final Exam either as a DOCX or PDF file.

First question starts on the next page.

1. Using the example network given in the below figure, 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.



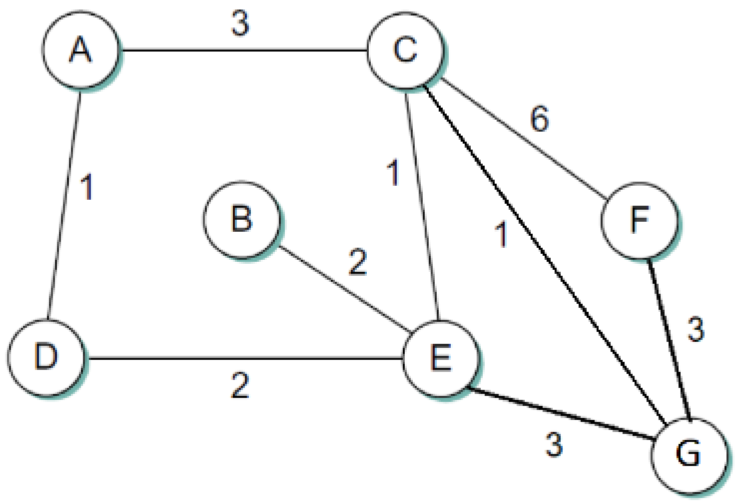
a. (10 points)
Host C connects to Host K

b. (10 points)
Host C connects to Host G

c. (10 points)
Host K connects to Host I

Question	Switch	Input port	Input VCI	Output port	Output VCI
a	1	3	0	1	0
	2	3	0	1	0
	4	3	0	1	0
	5	2	0	0	0
b	1	3	1	1	1
	2	3	1	1	1
	4	3	1	1	1
	5	2	1	1	0
c	5	0	1	2	2
	4	1	2	3	2
	2	1	2	0	0
	3	0	0	2	0

For questions 2 and 3, refer to the following figure:



2. (40 points)

Give the datagram forwarding table for nodes A, C, D, and G. The links are labeled with relative costs; your tables should forward each packet via the lowest-cost path to its destination.

Notde A:	
Desitionaiton	Next hop
B	D
C	C
D	D
E	D
F	C
G	C

Node C:

Destination	Next hop
A	A
B	E
D	E
E	E
F	G
G	G

Node D:

Destination	Next hop
A	A
B	E
C	E
E	E
F	E
G	E

Node G:	
Destination	Next hop
A	C
B	C
C	C
D	C
E	C
F	F

3. For the above figure, give global distance vector tables when:
   a. (10 points)
   Each node knows only the distances to its immediate neighbors.
   b. (10 points)
   Each node has reported the information it had in the preceding step to its immediate neighbors.
   c. (10 points)
   Step (b) happens a second time.

a:

	A	B	C	D	E	F	G
A	0	Infinite	3	1	Infinite	Infinite	Infinite
B	Infinite	0	Infinite	Infinite	2	Infinite	Infinite
C		Infinite	0	Infinite	1	6	1
D	3	Infinite	Infinite	0	2	Infinite	Infinite
E	Infinite	2	1	2	0	Infinite	3
F	Infinite	Infinite	6	Infinite	Infinite	0	3
G	Infinite	Infinite	1	Infinite	3	3	0

b:

	A	B	C	D	E	F	G
A	0	Infinite	3	1	3	9	4
B	Infinite	0	3	4	2	Infinite	5
C	3	3	0	3	1	4	1
D	1	4	3	0	2	Infinite	5
E	3	2	1	2	0	6	2
F	9	Infinite	4	Infinite	6	0	3
G	4	5	1	5	2	3	0

c:

	A	B	C	D	E	F	G
A	0	5	3	1	3	7	4
B	5	0	3	4	2	7	4
C	3	3	0	3	1	4	1
D	1	4	3	0	2	7	4
E	3	2	1	2	0	5	2
F	7	7	4	7	5	0	3
G	4	4	1	4	2	3	0

4. (10 points)

Suppose a congestion-control scheme results in a collection of competing flows that achieve the following throughput rates:

900 KBps, 100 KBps, 1 MBps, 300 KBps, 2 MBps

Calculate the fairness index for this scheme. Show your work, otherwise, you will get zero credit.

Round your answer to two decimal places.

f(x1, x2, ..., xn) = [(Σi=1 to n xi)^2] / [n Σi=1 to n xi^2]

$$f(x_1, x_2, \ldots, x_n) = \frac{\left(\sum_{i=1}^{n} x_i\right)^2}{n \sum_{i=1}^{n} x_i^2}$$

For the given throughputs:

We calculate the sum of throughputs (Σ xi):

Σ xi = x1 + x2 + x3 + x4 + x5

Σ xi = 900 + 100 + 1,000 + 300 + 2,000

Σ xi = 4,300 KBps

Then, we get the sum of the squares of throughputs (Σ xi^2):

Σ xi^2 = x1^2 + x2^2 + x3^2 + x4^2 + x5^2

Σ xi^2 = 900^2 + 100^2 + 1,000^2 + 300^2 + 2,000^2

Σ xi^2 = 810,000 + 10,000 + 1,000,000 + 90,000 + 4,000,000

Σ xi^2 = 5,910,000

Finally, we have the values for the fairness index formula:

F = (Σ xi)^2 / (n * Σ (xi^2))

F = (4,300)^2 / (5 * 5,910,000)

F = 18,490,000 / 29,550,000

F ≈ 0.6256

5. Suppose a router has three input flows and one output. It receives the packets listed in the below table all at about the same time, in the order listed, during a period in which the output port is busy but all queues are otherwise empty. Give the order in which the packets are transmitted, assuming

For parts a and b, show your work. Otherwise, you will get zero credit.

a. (10 points)
Fair queuing.
b. (10 points)
Weighted fair queuing, with flow 1 having weight 2, flow 2 having weight 3, and flow 3 having weight 4.

Packet	Size	Flow
1	100	1
2	100	1
3	100	1
4	100	1
5	40	1
6	190	2
7	120	2
8	10	2
9	210	3
10	20	3

A:

$$F_i = \max(F_{i-1}, A_i) + P_i$$

Ai=0

Quesiton a:

Flow1:
Flow1_1=max(0,0) + 100 = 100
Flow1_2 = max(100,0) + 100 = 200
Flow1_3=max(200,0)+100 =300
Flow1_4=max(300,0)+100=400
Flow1_5_max(400,0)+40=440

Flow2:
Flow2_6 = max(0,0) + 190 = 190
Flow2_7=max(190,0) + 120=310
Flow2_8=max(310,0) + 10= 320

Flow3:

Flow3_9 = max(0,0) + 210 = 210
Flow3_10 = max(210,0) + 20 = 230

So, we get the fair qeuing is: 1,6,2,9,10,3,7,8,4,5

B:

Flow1: it is weight 2

Flow1_1 = max(0,0) + 100/2 = 50
Flow1_2 = max(50,0)+100/2=100
Flow1_3 = max(100,0) + 100/2 = 150
Flow1_4 = max(150,0) + 100/2=200
Flow1_5=max(200,0) + 40/2 = 220

Flow2: weight 3

Flow2_6 = max(0,0) + 190/3 = 63.3

Flow2_7 = max(63,3,0) + 120/3 = 103.3
Flow_8 = max(103.3,0) + 10/3 = 106.6

Flow3: weight 4

Flow3_9 = max(0,0) + 210/4 = 52.5
Flow3_10 = max(52.5,0) + 20/4 = 57.5

So, we know the order after weighted is: 1,9,10,6,2,7,8,3,4,5