1 Some Hints

Your professor suggests the following preparation strategies:

- Be Sure that you have the correct exam (there is a 416 and 516 version).
- This exam is open book and open notes (your own books and notes that is!). Calculators are permitted, networked devices are not.
- Write neat clean answers, since if the grader cannot understand you on the real exam, it will go badly for you.
- Show your work, if you are guessing the grader will not give much credit (even if you get lucky and guess right).
- Define your notation (you can use tables like the lecture notes if you like).
- Set up the solution symbolically and simplify before plugging numbers in, it is easier to follow for the grader.
- You can solve problems out of order, but keep the work for each problem in one place, and mark it clearly.
2 The Problems

1. Switching (30 points):
   (a) Draw a $8 \times 8$ Banyan switch, labeling the inputs and outputs starting at 0 (5 points).
   (b) Which of sets of the following (input,output) mappings will cause congestion in the banyan switch you drew for 1a, assuming uniform message size and simultaneous arrival (5 points)?
      i. $\{(0,1), (4,0)\}$
      ii. $\{(5,0), (7,1)\}$
      iii. $\{(1,4), (3,5)\}$
      iv. $\{(7,5), (1,6)\}$
      v. $\{(4,3), (3,4)\}$

2. Suppose that the switch you drew in 1a is idle except for a the set of (input, output) mappings, $\{(1,2), (5,3)\}$, and the switching elements use output buffering (one buffer per message). If each switching element output can transfer a message in $5 \times 10^{-7}$ seconds (on average) and that each input stream has messages arriving $1.05 \times 10^{-6}$ seconds apart (on average).
   (a) Suppose both the output service times and the input arrival times are exponentially distributed, then:
      i. Which switching element has the longest mean output queue length, and what is the mean length of that queue (5 points)?
      ii. What is the mean time for a message to go from the input to the output in this system (5 points)?
   (b) Suppose both the output and input service times are constant, then:
      i. Which switching element has the longest mean output queue length, and what is the mean length of that queue (5 points)?
      ii. What is the mean time for a message to go from the input to the output in this system (5 points)?

3. Scheduling (40 points):
   (a) Max-Min Fair Share (15 points): Consider a system with 5 sources which demands of 6, 8, 9, 5, 4 respectively, and a channel with capacity of 30.
      i. If each source has equal weighting, what is the max-min fair share allocation to each channel (5 points)?
      ii. If the weights of the channels are 8, 1, 3, 4, 7, what would the max-min weighted fair share allocation be (10 points)?
(b) GPS and WFQ (20 points): Give the arrival times and service completion times of each packet in the system. **Hint: Use of diagrams can make your life easier here!** Suppose that you have a scheduler managing connections $A, B, C$, with packets of size 10, 20, 30 respectively.

i. What is the GPS schedule of this system (5 points)?

ii. What is the WFQ schedule of this system assuming equal weights on each connection (5 points)?

iii. What is the WFQ schedule of this system assuming that the connections have weights of 1, 1, 3 respectively (10 points)?

iv. Suppose another packet of size 1 arrives on connection $A$ at time $t = 4$ and the connections had equal weights, what would the GPS schedule be (5 points)?

4. Distance vector Routing (20 points): Consider the configuration shown in Figure 1, and recall the distance vector routing algorithm.

![Network Diagram](image)

**Figure 1: Network in Problem 4**

(a) Show the initial condition of the system by giving each node's initial distance vector (5 points).

(b) Suppose that $B$ gets the initial distance vector from $D$, show how $B$ computes its updated distance vector (5 points).

(c) Suppose that $A$ gets the initial distance vector from $C$, show how $A$ computes its updated distance vector (5 points).

(d) Suppose that $A$ has the distance vector computed in 4c and compute how $A$ would update its distance vector after getting the vector from $B$ which you computed in 4b (5 points).
5. Addressing (10 points):

(a) What is the trade-off being accomplished by aging out DNS records (5 points)? (Hint: consider fast vs. slow aging.

(b) DNS assumes that an application accepts either a dotted-decimal IP address or a hostname, the application should attempt to resolve the name first by treating it as a dotted-decimal form and if that fails, resorting to the hostname. What would happen if, instead, an application tried to resolving as a hostname first and then dotted-decimal? (5 points).