

ECE697AA – Final Exam  
Spring 2008  
Prof. Wolf

Name: \_\_\_\_\_

ID Number: \_\_\_\_\_

	Maximum	Achieved
Question 1	16	
Question 2	10	
Question 3	10	
Question 4	16	
Question 5	16	
Question 6	12	
Total	80	

This exam is closed book, closed notes. Three pages of notes are allowed. No electronic devices (other than calculators) are allowed. Be concise, but show your work. Please write legibly.

Time: 120 minutes.

Question 1 (16 points):

Answer the following questions regarding lookup data structures.

- a) Consider binary prefix trees. Construct a binary tree that contains the address prefixes listed below. Let all “0s” branch to the left and all “1s” branch to the right. Mark nodes that correspond to a prefix with *A*, *B*, etc. (7 points)

IP prefixes:

- A. 0\*
- B. 000\*
- C. 001\*
- D. 1\*
- E. 101\*
- F. 1011\*
- G. 1001\*

- b) Which of the prefixes is returned on a lookup of 10101100? (2 points)

- c) Construct a multi-bit trie with a stride length of 2 for the same set of prefixes as above. Mark all the nodes that correspond to prefix matches. Expand all prefixes such that prefixes only occur in leaf nodes. (7 points)

IP prefixes (same as above):

- A. 0\*
- B. 000\*
- C. 001\*
- D. 1\*
- E. 101\*
- F. 1011\*
- G. 1001\*

Question 2 (10 points):

Answer the following questions regarding flow classification.

- a) Show the hierarchical tries data structure (without set pruning) that matches the rule set from above.

Rules (same as above):

R1: \*, 0\*

R2: \*, 11\*

R3: 0\*, 10\*

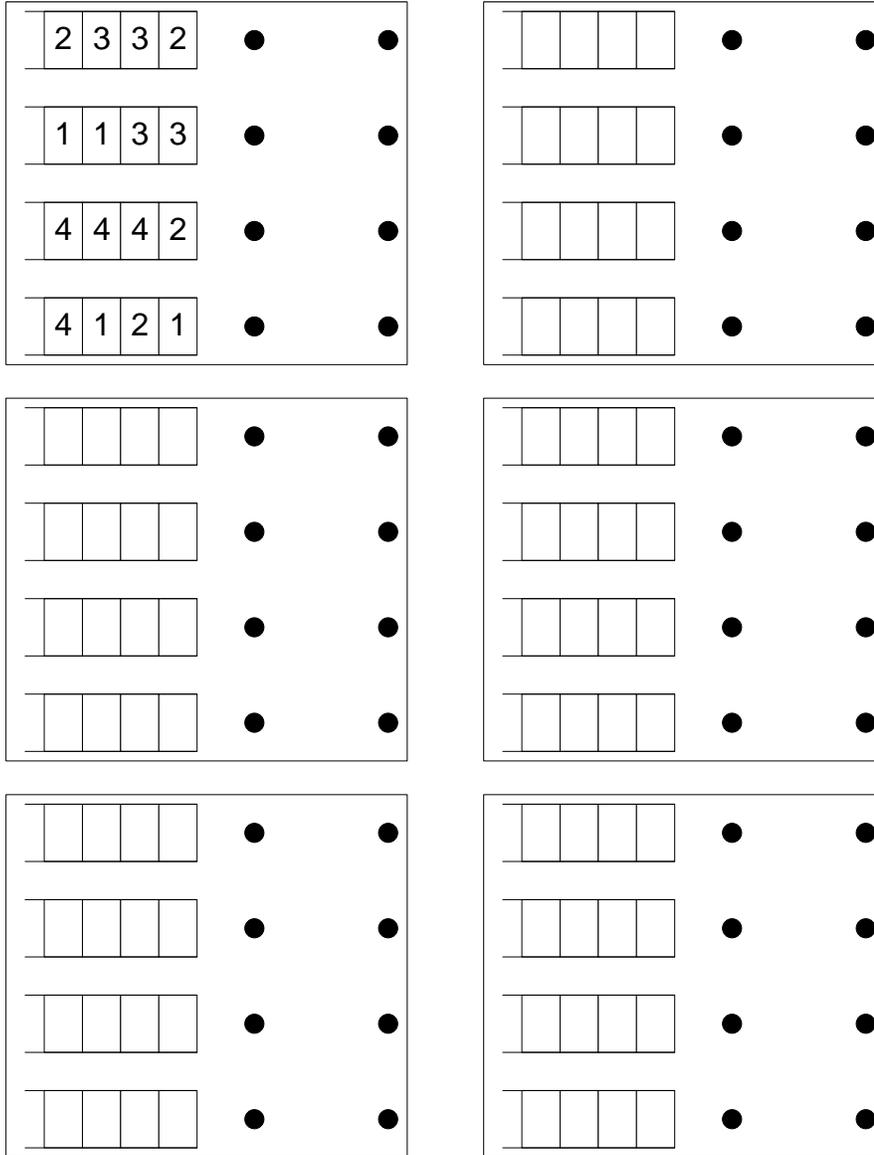
R4: 010, \*

R5: 110, 101

Question 3 (10 points):

Answer the following questions regarding a crossbar switching fabric.

- a) Given a 4 x 4 crossbar with the input queues shown below (ports are numbered 1...4), assume the queues need to be served in FIFO order. Give a feasible schedule for the scenario below. Show a packet transmission by connecting the input port dots with the output port dots. Show what packets are left in the next iteration. Show all necessary iterations. (8 points)

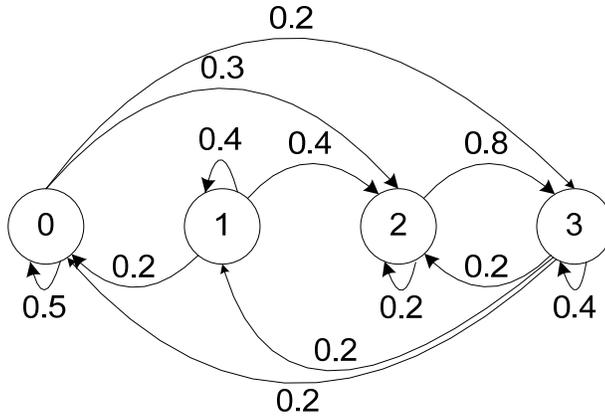


- b) Why does your solution require more than four iterations even though the output ports are not overloaded? (2 points)

Question 4 (16 Points):

Answer the following questions regarding discrete time Markov chains (DTMC).

- a) Given the Markov chain shown below, determine the corresponding transition probability matrix  $P$ . (4 points)

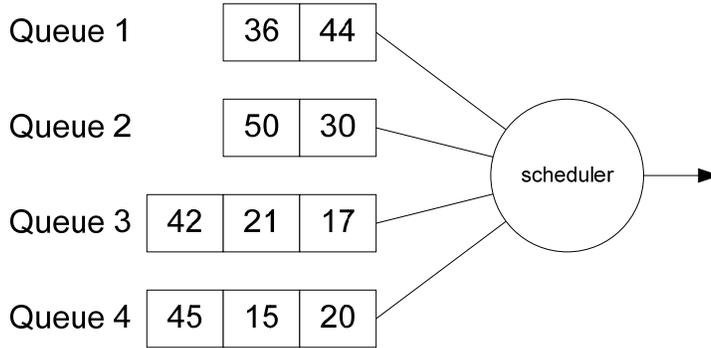


- b) Assume that at a particular instance of time, the probabilities of the Markov chain being in any of the four states is given by the vector  $q_t = (0.4, 0.3, 0.2, 0.1)$ . What is the probability vector  $q_{t+1}$  at the next step in time? (4 points)

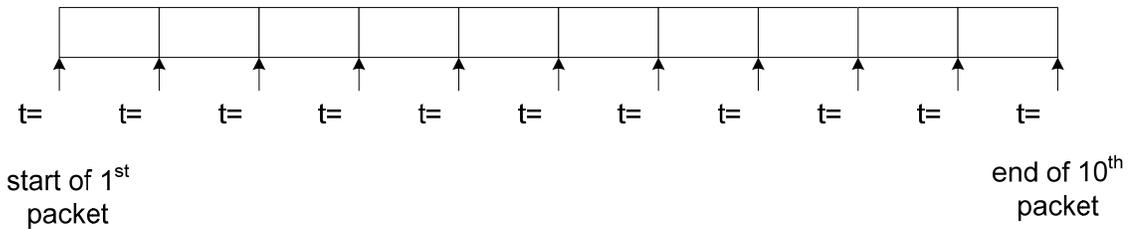
c) What is the steady state probability vector  $\pi$  for this Markov chain? (8 points)

Question 5 (16 points):

Answer the following questions regarding link scheduling. Assume all packet sizes are in bits and the link speed is one bit per second. You can also assume that all packets are in their respective queues at time  $t=0$ . If several packets are eligible to be transmitted, then the scheduler chooses the one with the lower queue number.

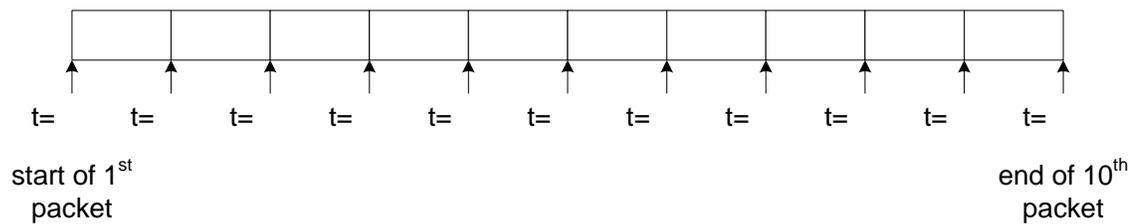


- a) Given a packetized round robin scheduler, show the order of packets that are transmitted on the link. For each packet note the size (which uniquely identifies each packet in this example) in the box and the start and finish time underneath the arrow in the diagram below. (4 points)



- b) Given a WFQ scheduler (with equal weights for each queue), what do you need to compute for each packet to determine the schedule? Show your calculations in the table below. Then show the resulting WFQ schedule (10 points)

packet	44	36	30	50	17	21	42	20	15	45



- c) What is the key difference between WFQ and WF<sup>2</sup>Q scheduling? (2 points)

Question 6 (12 points):

Answer the following questions regarding various topics in networking.

- a) If you could choose any metric for the purpose of routing, which one would you choose for each of the following applications to obtain the “best” path? (3 points)

1. Voice over IP: \_\_\_\_\_

2. Video download: \_\_\_\_\_

3. Non-real-time UDP-based application: \_\_\_\_\_

- b) When designing larger networks (e.g., campus network), it is recommended to connect LANs with routers rather than switches. Give 4 reasons why routers are preferable. (4 points)

1. \_\_\_\_\_

2. \_\_\_\_\_

3. \_\_\_\_\_

4. \_\_\_\_\_

- c) Why does slotted ALOHA achieve higher throughput than pure ALOHA? (3 points)

- d) What is the purpose of ARP and DNS? (2 points)

ARP: \_\_\_\_\_

DNS: \_\_\_\_\_