CSCI 415 Data Communication Networks
Test 2
take home on 04/28/08
return on 04/30/08

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NAME:———————————

- There are 3 Problems (but each problem has multiple parts).
- Make sure your answer is clear.
- Do not leave unanswered questions even if you think you do not have the complete answer. Partial credit **might** be given.
- Read all questions first. This will help you identify which questions you can easily answer first.

Problem 1: M/M/1 systems (10 points)

Problem 2: Fairness index (10 points)

Problem 3: A simple AIMD (10 points)

Total: (30 points)

Problem 1: M/M/1 systems

(a) Consider the following system. Packets arrive according to a Poisson process of rate λ to node 1. Node 1 does not process any packets, however, it simply forwards those packets with equal probability to either node 2 or node 3. Both node 2 and node 3 have a memoryless service with rate μ and infinite queues.

What is the expected number of packets in the system and the expected delay per packet?

(b) Consider the same system except that node 1 now stops forwarding any packets and starts to serve the packets using its memoryless service of rate 2μ and its infinite queue.

What is the expected number of packets in the system and the expected delay per packet?

(c) What do you conclude as a general remark?

Problem 2: Fairness index
Suppose a congestion control scheme results in a collection of flows that achieve the following throughput rates: 100 KBps, 60 KBps, 110 KBps, 95 KBps, and 150 KBps.

(a) Calculate the fairness index for this scheme.

(b) Add a flow with throughput rate of 1000 KBps to the above, and recalculate the fairness index.

Problem 3: A simple AIMD

Consider a simple congestion control algorithm that uses linear increase and multiplicative decrease (no slow start). Assume the congestion window size is in units of packets rather than bytes, and it is one packet initially.

(a) Give a detailed description of this algorithm.

(b) Assume that for every group of packets sent, only one cumulative ACK is returned. Plot the congestion window size as a function of time (units of RTT) when the following packets are lost: 9, 25, 30, 38, and 50. For simplicity assume the timeout is equal to 1 RTT.

(c) What is the effective throughput achieved for this connection if each packet is 1KB and the RTT is 100ms?

(d) Explain why changing *cwnd* each time an ACK arrives using the following formula

$$cwnd = cwnd + MSS \times (MSS/cwnd)$$

is not correct for such algorithm (or in general).