Elec 428
Spring Semester 2006

Final Exam

This is a 2-hour, open-book, open-notes, take-home exam. Work the exam on standard 8.5" x 11" paper, **one side only**. If a problem statement appears ambiguous or incomplete, make any *reasonable* assumptions that you feel are necessary to solve the problem and state those assumptions as part of your solution. The exam is due by 12 noon on Thursday, May 4, for all graduating students; it is due by 5 PM on Wednesday, May 10, for all non-graduating students. Hand in your exam directly to me or one of the staff in the Dean's office – do not put it in the box in Abercrombie or in my mail box. You may use a calculator, Matlab, Mathematica, Excel, or other computational software, but do not use preprogrammed algorithms of any kind for MVA.

Show all your work. No partial credit for incorrect answers can be given otherwise, and full credit for correct answers may not be given without it.

SIGN THE PLEDGE

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1. A closed queueing network consists of three queues. Queue 1 is a LCFSPR queue with a single server and a service rate of 5. Queue 2 is a PS queue with a service rate of 4. Queue 3 is an IS queue with a service rate of 1 for each job in the queue. There are two jobs total in the network. A job leaving queue 1 goes to queue 2 with probability 0.2 or to queue 3 with probability 0.8. Jobs leaving queue 2 or queue 3 always go to queue 1.

   (a) What is the average number of jobs in queue 2 in steady state? (10 pts)

   (b) What is the probability that queue 2 contains 2 jobs in steady state? (10 pts)

   (c) What is the throughput of queue 3? (5 pts)

2. A computer installation has three computers and two repairmen. Computers are either working or broken. Each working computer fails with rate 0.1 failures per hour according to an exponential distribution, independently of the state of the other computers. If one computer is broken, one repairman is working on it, and fixes it in an exponentially distributed repair time with mean 5 hours. If two computers are broken, one repairman works on each computer, with the time to repair each computer exponentially distributed with mean 5 hours. Should all three computers be broken, only two are in repair; as soon as one of the two in repair is fixed, the repairman who completed the repair immediately begins to work on the computer that had been waiting to be repaired.

   (a) What is the average number of working computers? (10 pts)

   (b) What is the average number of working repairmen? (5 pts)

   (c) What is the probability that when a computer breaks there is no repairman available at that instant to work on it? (10 pts)

3. (a) Find the average number of jobs in an M/M/3/5/6 queue with $\lambda = 1$ and $\mu = 0.5$. (10 pts)

   (b) What is the average time that a single job spends in this queue? (15 pts)

4. In a head-per-track disk, every track on the disk surface has a separate, fixed-position read/write head. Jobs arrive according to an exponentially distributed inter-arrival time with rate 100 jobs per second. The disk spins at 14,400 RPM. Each data transfer (write of data to the disk or read of data from the disk) takes 0.1 msec with probability 0.5 or 0.2 msec with probability 0.5, measured from the time the first bit position of the data on the selected track comes under the read/write head for that track. Switching from track to track (from one read/write head to another) takes essentially zero time. What is the average time required to complete a disk access request, including waiting time and disk service time? (25 pts)