COMP SCI/SFWR ENG 4/6E03 — Assignment 8

1. Suppose we have the following web server network. There are 250 clients using it, where each client thinks for a mean time of 1 second before generating a request, and each client may have only one outstanding request in the system. The request first arrives to a dispatcher. The dispatcher alternates sending requests between two identical web servers in parallel. After processing at one of the web servers, the request is either completed or requires a database server access (there is just one database server). After a database server access, a request returns to the web server at which it was originally processed. This continues until the request is completed and the result is returned to the user. The expected processing times (in milliseconds) per visit are 0.8 for the dispatcher, 1.2 for the web servers and 1.2 for the database server. The expected number of visits to the database server per request is 3. Use mean value analysis to calculate the actual system throughput, the expected utilization of each resource and the expected waiting time time for a request. State any assumptions you needed to make so that MVA is applicable.

2. Consider the following system, consisting of a CPU and two I/O devices. Processing times at the CPU have mean $1/\mu_0$. After processing at the CPU, a job immediately returns to the CPU with probability p_0, uses I/O device one (I/O1) with probability p_1 or uses I/O device two (I/O2) with probability p_2. Processing times at I/O1 and I/O2 are exponentially distributed with means $1/\mu_1$ and $1/\mu_2$, respectively. After processing is complete at the I/O devices, jobs return to the CPU. Let $\mu_0 = 2$ per second, $\mu_1 = \mu_2 = 1.2$ per second, $p_0 = 0.1$, $p_1 = 0.3$ and $p_2 = 0.6$. Three jobs circulate through the network. Using the product-form steady-state distribution, calculate the utilization of the CPU.

3. A network consists of three single server nodes. External arrivals to the first node follow a Poisson process with rate 10 per minute. After service at node 1, jobs go to node 2 with probability .5 and go to node 3 otherwise. After service at node 2, jobs return to node 2 with probability .7 and go to node 3 otherwise. After service at node 3, jobs always exit the system. The service times at each node are exponentially distributed, with the following means: Node 1 - 5 seconds, Node 2 - 2 seconds, Node 3 - 4 seconds.
   (a) Find the expected number of jobs at node 2.
   (b) If you could increase a processing rate, which would be your first choice? Which would be your last choice?

4. You have a single processor implementing FCFS and are given the option of three different processing time distributions: (i) exponential with rate two per minute, (ii) uniformly distributed between 10 and 50 seconds, (iii) equal to exactly 10 or 50 seconds with equal probability. If the performance measure is mean waiting time, which would you choose?