ECES 798 Performance Evaluation
Exam 1
Time: 1 hr 15 min
Total Points: 35

Name: Solution Key

1. Suppose, we start a discrete event simulation by scheduling a single event in the future event list (FEL) with timestamp 0, and the simulation is such that *each* event in the simulation **schedule**s *exactly* one other event. How many events will there be in the FEL after the first *k* events have been **cause**d and executed and the program is about to **cause** the next event.

   [5]

   Each event schedules one other event. When an event is processed it is deleted from the FEL. Thus there will be just one event in the FEL.

   Now solve the same problem, but when each event in the simulation schedules exactly *i* events ($i > 0$).

   [5]

   k events schedule a total of $k*i$ events in the FEL. There will be *k* event deletions from the FEL. Thus, counting the very first event, there will be $k*i - k+1$ events in the FEL.

2. State one drawback of using arithmetic mean of ratios of execution times for summarizing performance of several computer systems on a number of benchmark programs. [5]

   Arithmetic mean of ratios is sensitive to the "base" used to compute the ratios. If arithmetic means are used to compare performance, for the same performance data set, computer A can be shown to be better than computer B, for a given base computer (say, C), while computer B can be better than computer A, for a different base computer (say, D).

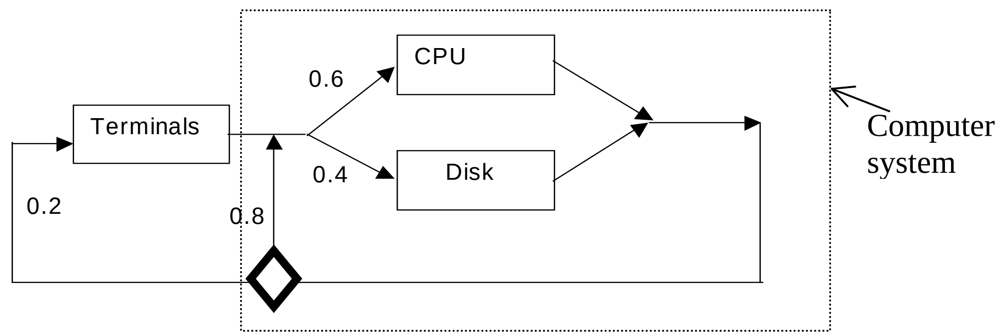
3. Consider the interactive computer system model shown in the following diagram. The labels on the links are probabilities. There are 10 terminals. The following parameters are obtained via measurements:

   Terminal Average think time = 1.00 sec.

   CPU Average service time = 50 ms.
   Average response time = 233 ms.

   Disk Average service time = 100 ms.
   Average response time = 400 ms.

The above times are *for each pass* through CPU or Disk. Note that a job may make multiple passes. The probabilities at each fork points are as shown.



[Helpful hint: The distribution of the number of trials up to and including the first success in a sequence of *Bernoulli* trials is modeled by a geometric distribution. If *p* is the probability of success, the mean of the distribution is *1/p*.]

Compute the visit ratios for the CPU and disk. [4]

A job will visit the point denoted by the diamond 1/0.2 = 5 times on an average. This also means that the job will make 5 trips through the computer on an average.

$V_{CPU} = 5*0.6 = 3$; $V_{disk} = 5*0.4 = 2$

Compute the average response time for the computer system. [4]

R = (3*233 + 2*400) ms = 1.5 sec.

Compute the total throughput in jobs completed by the computer system per sec. [3]

Use, R = N/X – Z. R, N and Z are known. X = 4 jobs/sec.

What is the average number of jobs in the computer system? [3]

Avg. #jobs = X*R = 6.

Carry out a bottleneck analysis to determine the asymptotic bounds of the response time vs. no. of terminals curve. What is value of no. of terminals at the knee (i.e., value of N*)? [6]

$U_{CPU} = X*D_{CPU} = 4*(50*3/1000) = 0.6$
$U_{disk} = X*D_{disk} = 4*(100*2/1000) = 0.8$
Disk is the bottleneck device. $X_{max} = 1/D_{disk} = 1/0.2 = 5$ jobs/sec
The asymptotes are $R_{min} = 3*50 + 2*100 = 350$ ms = 0.35 sec, and
$R(N) = N/X_{max} – Z = N/5 – 1 = 0.2N – 1$ sec. Solve for N, to get N* = 6.75.