CS 350
Assignment4
Due Date: 17th March @ 11:59pm using gsubmit only. No email submission will be accepted.

Feel free to make assumptions, if you feel that such assumptions are justified or necessary. Please state your assumptions clearly. Unreasonable assumptions lead to unreasonable grades!

1. The execution of processes submitted to the system proceeds as follows:

   1. The process uses the CPU and then with a probability 0.1 proceeds to step (2), with probability 0.4 proceeds to step (3), and with probability 0.5 proceeds to step (4).
   2. The process performs a disk I/O and then with a probability 0.5 proceeds to step (1), and with probability 0.5 proceeds to step (3).
   3. The process performs a network I/O and then proceeds to step (1).
   4. The process is done!

   The following information is known about the above system.

   - Process arrivals are Poisson with a rate of 40 processes per second
   - The CPU is a dual-core design; the ready queue is serviced by any one of the 2 CPU cores.
   - The CPU service time is exponential with mean of 20 msec
   - Disk I/O service time is exponential with mean of 100 msec
   - Network service time is exponential with mean of 25 msec
   - There is plenty of memory, so all buffers are of infinite size

   Answer the following questions:

   (a) Draw a queuing network representation of the above system.

   (b) Find the average turnaround time (i.e. total response time) for processes submitted to the above system.

   (c) What service (CPU, Disk, or network) is the "bottleneck" in the above system? Why?

2. Write a discrete-event simulator (Using SimPy) for the system described in problem 1 above. Run your simulator for a period of 100 seconds and answer the following:

   (a) Plot the number of requests waiting in the CPU queue as a function of time. Note: Obtain a measurement using PASTA principle every (simulated) second on average and plot your measurement as a function of time (i.e., from time 0 to time 100) using spreadsheet software such as Excel.

   (b) Determine a point in the simulation after which you feel confident that the system has reached a steady state.

   (c) Compute the 95th and 98th percentile confidence interval for the:

      - Number of requests in the CPU queue at steady state

- Response time through the entire system at steady state

(d) How do the results you obtain from this simulation compare to those you got analytically in problem 1?

(e) Also find out λ_{cpu}, $\lambda_{network}$, λ_{disk} from the simulator. Are these in agreement with the analytical results?

3. Repeat problem 2, but with the following assumptions:

   - Process arrivals are Poisson with a rate of 40 processes per second CPU service time is uniformly distributed between 1 and 39 msec
   - Disk I/O service time is normally distributed with mean of 100 msec and standard deviation of 30 msec (but never negative)
   - Network service time is constant and equal to 25 msec
   - All buffers are of infinite size

   How do the results you obtain from this new simulation compare to those you got in problem 2? Comment on whether any similarities or differences make sense.

What to hand in: Source code that we can compile, and answers to all parts that shows your analytical or experimental work.