[1] (15 points)

Customers arrive at an order counter with exponential interarrivals with a mean of 10 minutes. A single clerk accepts and checks their orders and processes payments, UNIF(8, 10) minutes. Upon completion of this activity, orders are randomly (50% chance) assigned to one of two available stock persons who retrieve the orders for the customers, UNIF(16, 20) minutes. Upon receiving their orders, the customers depart the system. Develop a model of this system and run the simulation (one replication) for 5,000 minutes.

(a) Compute:

i. Average work in process for the system (WIP).

ii. Average total time in system (cycle time).

iii. Average waiting time for retrieve orders of queue 1.

iv. Average number waiting for retrieve orders of queue 2.

(b) Replicate the simulation 10 times and compute 95% confidence intervals for (i) above.

(c) What are the numbers of replications needed to reduce the half width of the 95% confidence intervals for part (b) above to 2.5 customers?

(d) A bright, young operations research analyst has recommend that they eliminate the assignment of an order to a specific stock person and allow both stock persons to select their next activity from a single order queue. Develop a model of this system, run it (one replication) for 5,000 minutes, and compute:

i. Average work in process for the system (WIP).

ii. Average total time in system (cycle time).

(e) Compare the results of (i) and (ii) in (a) and (d), which configuration you think is better and why?

[2] (6 points)

Consider the linear congruential generator (LCG) defined by

$$Z_i = (aZ_{i-1}+c) \bmod m.$$

Generate a sequence of **three** Uniform (0,1) pseudo-random numbers, take m = 100, a = 17, c = 43 and $Z_0 = 27$.

Use the pseudo-random numbers generated above to generate a discrete random variable X having the following probability density functions

X	-2	-1	0	3	4	5
P(x)	0.15	0.1	0.20	0.15	0.2	0.2

[3] (8 points)

Consider Model 12-2, the model of a small manufacturing system. Use the common random numbers approach as variance reduction technique, run the model with two alternatives A (mean arrival rate 1/11) and B (mean arrival rate 1/10.5) and consider the average total work in process as your measure of performance. In the Statistics Model add a new row with Name: Avg Total WIP, Type: Output , Expression: DAVG (Total WIP), Report label: Avg Total WIP, and output file fileA.dat for alternative A and fileB.dat for alternative B.

Use the Output Analyzer to perform Paired-t Comparison of Means using files FileA.dat and FileB.dat to determine the following:

A. Estimated mean Difference.

B. 95% Confidence Interval Half-Width.

C. Do we reject or Accept H_0 (means of the two data sets are equal)

[4] (11 points)

Parts arrive at a two machine system according to an exponential interarrival distribution with mean 20 minutes. Upon arrival, the parts are sent to machine 1 and processed. The processing time distribution is TRIA(4.5, 9.3, 11) minutes. The parts are then processed at Machine 2 with a processing time distribution as TRIA(16.4, 19.1, 21.8) minutes. The parts from Machine 2 are directed back to Machine 1 to be processed a second time (same processing time). The completed parts then exit the system. Run the simulation for 10 replications of 10,000 minutes.

(a) Compute:

i. The average number in the machine queues (machine 1 and 2).

ii. Average part cycle time.

(b) Suppose that machine 1 fails sometimes. Uptimes for machine 1 are exponential with mean 120 minutes and repair times are exponential with mean 10 minutes. Compute

iii. The average number in the machine queues (machine 1 and 2).

iv. Average part cycle time.