Name: _____ **Seat#:** _____ **Academic#:** _____

INSTRUCTIONS:

Do not turn to the first page of the exam until you are told to do so. You have 170 minutes to complete this exam. The test is CLOSE book and CLOSE notes. But you are allowed to bring two A4 sheets.

Do not spend too much time on one problem. Pay attention to points assigned to each part. If you run short on time, set the problem up and skip the algebra or arithmetic.

Good Luck.

1. (10 pts.) For each part, name the relevant probability distribution, state any known parameter values, and list any parameter values that need to be determined.

   (a) The result of a die toss.

   (b) Of 100 phone calls made by a particular telemarketer, the number that are answered by a person.

   (c) The number of calls made by a particular telemarketer to contact one person.

   (d) The number of calls made by a particular telemarketer to contact five people.

   (e) Suppose that in a small town of 2000 people, 15 are interested in the telemarketer's product. The telemarketer contacts 800 people. The number of people contacted who are interested in the product.

2. (20 pts) Identify a common property for each part. Common properties include but are not limited to the following items:
   random variables, constants, events, measuring center of gravity, measuring variability, population parameters, characteristics of a sample, and meaningless.

   (a) $E(X)$ and $\overline{X}$

   (b) Var(X) and S^2

   (c) $E(X)$ and Var$(X\ )$

   (d) $\overline{X}$ and S^2

   (e) $\overline{x}$ and s^2

   (f) σ_X and σ_Y

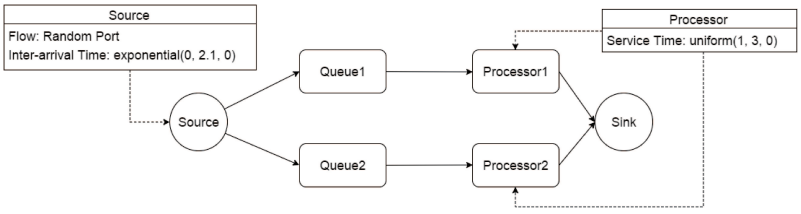
   (g) E$(X > 10)$ and Var$(\mathrm{X} < 10)$

   (h) $\{X > 10\}$ and $\{X < 10\}$

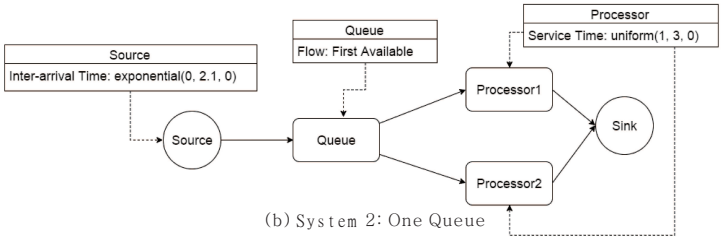
   (i) P$(\mathrm{X} > 10)$ and P$(\overline{\mathrm{X}} < 10)$

   (j) $E(X)$, Var(X), $\overline{x}$, s^2

3. (40 pts) Comparing two systems listed in the following plot in terms of the E(LQ) and E(WQ). You are asked to use Flexsim to model these two systems. Run to Time: 2000 Warmup time: 200 Rep 50. You need to use experimenter in Flexsim. You need to draw confidence interval plot for E(LQ) and E(WQ). (hint: use Minitab to draw confidence interval)



(a) System 1: Two Queues



(b) System 2: One Queue

(a) System 1: two queues

Source: (1) Inter-arrival time follows exponential(0, 2.1, 0); (2)Flow: Random Port.

Processor: Process time follows uniform(1, 3, 0)

(b) System2: : one queue

Source: Inter-arrival time follows exponential(0, 2.1, 0).

Queue: Flow: First available

Processor: Process time follows uniform(1, 3, 0)

4. (10 pts.) Estimate $\int_0^{10} x^3 dx$ via simulation. (hint. You can use MSExcel to generate data)

5. (20 pts.) Prove Central Limit Theorem (CLT) via simulation (either MS Excel or Minitab). Let $X_1, X_2, \ldots X_n$ follow Bernoulli ($p = 0.9$). Let μ_X and σ_X be the mean and standard deviation of X. Draw the histogram of the "standardized $\overline{X}(n)$" for $n = 1, 2, 30$, and 100. Put these four plots in the same figure.