MCP261 IE Lab I: Exercise 4 **January 31, 2024**

Exercise 4: Discrete Event Simulation II

Due date: 11:59 PM Feb 4, 2024

Submission Instructions

Each Python file *must* be easy to read: all variables and key quantities of interest must be clearly named, all computations must be commented, all assumptions must be very clearly stated, and finally, you may even add a short explanation of your approach to the problem at the beginning of the .py file. The exercise must be submitted as a zipped folder containing two Python files (.py scripts only – no .txt files or Jupyter notebooks will be entertained) – one for each question. Naming convention for the zipped folder: Name_EntryNum_Exercise#.zip. Naming convention for the Python file for each question: Name_Exercise#_Question#.py. Your submission will be heavily penalized if it does not follow the above requirements.

Exercise 4 Description

For all questions below, use a random number seed of 1234.

1. (6 marks) Consider a system with n machines – one is an active machine and the others are inactive spares. One of the spare machines, chosen at random, becomes active when the (currently) active machine fails, while the failed machine immediately starts repair. The failed machine becomes a spare when its repair is completed. Only one component at a time can be repaired, so the system as a whole fails if all machines have failed, and it is operational as long as at least one of the machines is working. The time to failure of a machine can with equal probability be 1, 3, 5, 7 or 9 days, while repair takes exactly 10.5 days. A repaired machine is as good as new.

   Modify the TTF simulation such that it works with any number of machines (integer > 1). Find and print the average and SD of the time to failure with 5 machines (100 replications). Plot the graph of average time to failure against number of machines when the number of machines ranges from 2 to 7. The graph must be properly plotted, with axes clearly labeled.

2. (9 marks) Write code in Python to simulate an M/G/1 queueing system with arrival rate = 8 entities per hour and service time distribution is a Gaussian distribution with mean 5 minutes and standard deviation 1 minute (if you obtain a negative sample from the service time distribution, replace it with its absolute value). Note that no DES package should be used. Calculate the following performance measures: average and standard deviation of wait time, length of stay, average queue length, server utilization. Conduct 100 replications, and the simulation must be run for 500 hours. Note that the first three performance measures will be estimated as an average from each replication, and hence the required output across all replications will be the average and standard deviation of the average measures computed from each replication.