**Tut questions for queueing simulation (for 12 September)**

**Question 1**

Interarrival times of vehicles at a customs gate are exponential distributed with lambda = 10 vehicles per hour and it takes on average 5 minutes to inspect a vehicle (service times are also exponential distributed). Vehicles are inspected one by one and vehicles waiting to be inspected fall in a single line for service. Show that simulated values for time in the system converges to the analytical result of an M/M/1-queue.

**Question 2**

For the Port of New Orleans example: suppose an improvement of the unloading process results in a new probability distribution for the daily unloading rate:

|  |  |
| --- | --- |
| Daily unloading rate | Probability |
| 1 | 0.03 |
| 2 | 0.12 |
| 3 | 0.40 |
| 4 | 0.28 |
| 5 | 0.12 |
| 6 | 0.05 |

Redo the simulation with the new daily unloading rate distribution (you can use the same random numbers from the class example). How do the new results compare against the those of the initial unloading rate distribution?

**Question 3 (previous DCE question)**

The eye test machine at a drivers license renewal centre is very reliable. The only regular maintenance item is the internal light bulb, which needs to be replaced whenever it fails, otherwise the machine cannot be used. A light bulb failure results in a closure of the license renewal section at the centre. Customers must then come back on a different day, or use another renewal centre.

Time between light bulb failures follows a normal distribution with a mean of 500 hours, and a standard deviation of 50 hours.

A local company has the contract to replace the light bulb whenever a failure occurs. They usually have replacement bulbs in stock and can carry out the repair within 1-3 hours. If they do not have the light bulb in stock, they have to order in from the main supplier and this results in longer repair times, up to 24 hours. Repair time follows the discrete distribution shown in the table below:

|  |  |
| --- | --- |
| Time (hours) | Probability |
| 1 | 0.2 |
| 2 | 0.3 |
| 3 | 0.2 |
| 12 | 0.2 |
| 16 | 0.09 |
| 24 | 0.01 |

a) Simulate until time elapsed is just more than 10 000 hours for the centre's light bulb maintenance policy. Use a linear congruential random number generator (LCG) with good parameters to generate the required random numbers with an increment of 2 100 000 000 and a seed number of 789 987 000. Use the same random number set for all the random variables that you use in your simulation (no need to create additional random number sets). Remember to use appropriate column headings for any columns that you add.

b) The contracted repair cost is R2500 per repair. However, the downtime cost is estimated to be in the region of R4000 per hour that the machine is out of use, and is based on lost revenue and customer inconvenience cost. Calculate the average cost per failure based on the information above and the simulation that you performed in a). Clearly show all calculations.