CSE 215  
Operation Research and Optimization Techniques

Lab 3  
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Simulation Report: Tandem Queue System

# 1. Introduction

This report presents the results of simulating a tandem queue system with two single servers. The goal of the simulation is to estimate the time average number of customers in the system under various conditions and to compare these results with steady-state predictions.

# 2. Methodology

## 2.1 Simulation Parameters

- Arrival Process: Poisson with rate λ  
- Service Times: Exponential with rates μ1 for server 1 and μ2 for server 2  
- Initial Queue Length: q customers in the first queue  
- Time Horizon: T  
- Number of Simulations: N

## 2.2 Parameter Values

- λ: {1, 5}  
- μ1: {2, 4}  
- μ2: {3, 4}  
- T: {10, 50, 100, 1000}  
- q: {0, 1000}

## 2.3 Simulation Procedure

1. Generate interarrival and service times according to their prescribed distributions.  
2. Simulate the queue length process and compute the corresponding integral.  
3. Perform the simulations N times for each combination of parameters.  
4. Report the average number of customers in the system.  
5. Compare the simulation results with steady-state predictions.

# 3. Results and comparison of variation parameters values For Average Customers (Theoretical): Such

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| q | λ | μ1 | μ2 | T | Average Customers (Simulation) | Average Customers (Theoretical) |
| 0 | 1 | 2 | 3 | 10 | 1.71 | 1.5 |
| 0 | 1 | 2 | 3 | 50 | 1.74 | 1.5 |
| 0 | 1 | 2 | 3 | 100 | 1.77 | 1.5 |
| 0 | 1 | 2 | 3 | 1000 | 1.81 | 1.5 |
| 0 | 1 | 2 | 4 | 10 | 1.67 | 1.33 |
| 0 | 1 | 2 | 4 | 50 | 1.61 | 1.33 |
| 0 | 1 | 2 | 4 | 100 | 1.72 | 1.33 |
| 0 | 1 | 2 | 4 | 1000 | 1.70 | 1.33 |
| 0 | 1 | 4 | 3 | 10 | 1.28 | 0.83 |
| 0 | 1 | 4 | 3 | 50 | 1.24 | 0.83 |
| 0 | 1 | 4 | 3 | 100 | 1.23 | 0.83 |
| 0 | 1 | 4 | 3 | 1000 | 1.23 | 0.83 |
| 0 | 1 | 4 | 4 | 10 | 1.21 | 0.67 |
| 0 | 1 | 4 | 4 | 50 | 1.15 | 0.67 |
| 0 | 1 | 4 | 4 | 100 | 1.15 | 0.67 |
| 0 | 1 | 4 | 4 | 1000 | 1.13 | 0.67 |
| 0 | 5 | 2 | 3 | 10 | 17.80 | Unstable |
| 0 | 5 | 2 | 3 | 50 | 78.80 | Unstable |
| 0 | 5 | 2 | 3 | 100 | 155.84 | Unstable |
| 0 | 5 | 2 | 3 | 1000 | 1502.47 | Unstable |
| 0 | 5 | 2 | 4 | 10 | 17.16 | Unstable |
| 0 | 5 | 2 | 4 | 50 | 77.86 | Unstable |
| 0 | 5 | 2 | 4 | 100 | 151.28 | Unstable |
| 0 | 5 | 2 | 4 | 1000 | 1498.09 | Unstable |
| 0 | 5 | 4 | 3 | 10 | 13.67 | Unstable |
| 0 | 5 | 4 | 3 | 50 | 55.32 | Unstable |
| 0 | 5 | 4 | 3 | 100 | 106.25 | Unstable |
| 0 | 5 | 4 | 3 | 1000 | 1002.43 | Unstable |
| 0 | 5 | 4 | 4 | 10 | 11.22 | Unstable |
| 0 | 5 | 4 | 4 | 50 | 38.20 | Unstable |
| 0 | 5 | 4 | 4 | 100 | 67.61 | Unstable |
| 0 | 5 | 4 | 4 | 1000 | 560.75 | Unstable |
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|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
| q | λ | μ1 | μ2 | T | Average Customers (Simulation) | Average Customers (Theoretical) |
| 1000 | 1 | 2 | 3 | 10 | 1017.07 | Unstable |
| 1000 | 1 | 2 | 3 | 50 | 982.01 | Unstable |
| 1000 | 1 | 2 | 3 | 100 | 954.27 | Unstable |
| 1000 | 1 | 2 | 3 | 1000 | 501.76 | Unstable |
| 1000 | 1 | 2 | 4 | 10 | 1021.27 | Unstable |
| 1000 | 1 | 2 | 4 | 50 | 981.70 | Unstable |
| 1000 | 1 | 2 | 4 | 100 | 954.84 | Unstable |
| 1000 | 1 | 2 | 4 | 1000 | 504.27 | Unstable |
| 1000 | 1 | 4 | 3 | 10 | 1002.65 | Unstable |
| 1000 | 1 | 4 | 3 | 50 | 954.21 | Unstable |
| 1000 | 1 | 4 | 3 | 100 | 902.52 | Unstable |
| 1000 | 1 | 4 | 3 | 1000 | 253.56 | Unstable |
| 1000 | 1 | 4 | 4 | 10 | 1001.26 | Unstable |
| 1000 | 1 | 4 | 4 | 50 | 937.35 | Unstable |
| 1000 | 1 | 4 | 4 | 100 | 865.46 | Unstable |
| 1000 | 1 | 4 | 4 | 1000 | 175.32 | Unstable |
| 1000 | 5 | 2 | 3 | 10 | 1030.12 | Unstable |
| 1000 | 5 | 2 | 3 | 50 | 1078.66 | Unstable |
| 1000 | 5 | 2 | 3 | 100 | 1155.55 | Unstable |
| 1000 | 5 | 2 | 3 | 1000 | 2508.29 | Unstable |
| 1000 | 5 | 2 | 4 | 10 | 1027.95 | Unstable |
| 1000 | 5 | 2 | 4 | 50 | 1080.02 | Unstable |
| 1000 | 5 | 2 | 4 | 100 | 1153.19 | Unstable |
| 1000 | 5 | 2 | 4 | 1000 | 2503.40 | Unstable |
| 1000 | 5 | 4 | 3 | 10 | 1020.76 | Unstable |
| 1000 | 5 | 4 | 3 | 50 | 1056.68 | Unstable |
| 1000 | 5 | 4 | 3 | 100 | 1105.62 | Unstable |
| 1000 | 5 | 4 | 3 | 1000 | 2003.14 | Unstable |
| 1000 | 5 | 4 | 4 | 10 | 1015.81 | Unstable |
| 1000 | 5 | 4 | 4 | 50 | 1037.84 | Unstable |
| 1000 | 5 | 4 | 4 | 100 | 1064.81 | Unstable |
| 1000 | 5 | 4 | 4 | 1000 | 1544.85 | Unstable |

# 4. Plots and comparisons













