

Assignment #8 for CIS 3320-005

Chapter 13 – Queuing Analysis

Read pages 607 through 635 of your textbook.

You will need to understand all the terminology and basic concepts used for each of the five types of waiting line models that are described in this chapter.

1. Learn how to calculate operating characteristics of the Single-Server Model using formulas.
2. Learn how to calculate operating characteristics of the Single-Server Model using the QM for Windows module “Waiting Lines > M/M/1 (exponential service times)”.
3. Learn how to calculate operating characteristics of the Undefined and Constant Service Time Model using formulas. NOTE: We will use **only** the case having Poisson distributed arrival times and constant service time with a single server.
4. Learn how to calculate operating characteristics of the Constant Service Time Model with a single server by using the QM for Windows module “Waiting Lines > M/D/1 (constant service times)”.
5. Learn how to calculate operating characteristics of the Finite Queue Length Model with a single server by using formulas **except** that we will use QM to determine the values for P_0 and L .
6. Learn how to calculate operating characteristics of the Finite Queue Length Model with a single server by using the QM for Windows module “Waiting Lines > M/M/1 with a Finite System Size”.
7. Learn how to calculate operating characteristics of the Finite Calling Population Model with a single server by using formulas **except** that we will use QM to determine the values for P_0 and P_n .
8. Learn how to calculate operating characteristics of the Finite Calling Population Model with a single server by using the QM for Windows module “Waiting Lines > M/M/1 with a Finite Population”.
9. Learn how to calculate operating characteristics of the Multiple-Server Model using formulas **except** that we will use QM to determine the values for P_0 , P_n and L .
10. Learn how to calculate operating characteristics of the Multiple-Server Model using the QM for Windows module “Waiting Lines > M/M/s”.

Work these problems from Chapter 13. Because of rounding, some of your answers might not exactly agree with the text, but you should be close.

- Single-Server: 7, 9, 15, 35(a), and 55 (first work manually then solve using QM)
- General or Constant Service Time: 21 and 23 (first work manually then solve using QM)
- Finite Queue Length: 53. First use QM to obtain the value of P_0 and L . Then work the problem manually. Finally, run it on QM. Some hints:
 - 1) Use “per month” for λ and μ (where one month is four weeks).
 - 2) “Busy” means at least one customer in the system, so Probability of “Busy” = $1 - P_0$.
 - 3) A customer will be able to place an order if the system is not full.
- Finite Calling Population: 25 (first work manually, except obtain P_0 using QM, then solve using QM)
- Multiple-Server Waiting Line: 29, 31, and 35(b) and (c). (Solve using QM but also be able to manually solve for W , L_q , and W_q if given necessary input values.)

IMPORTANT NOTE: You will find on Blackboard under Assignments a formula sheet that gives for each of the five waiting line models those formulas that you should be able to calculate manually on exams. If a formula needs a value that is not shown on this sheet, then that value should first be obtained using QM. On an exam, such a value would be given to you.

Work the following case problem as a Managerial Report for Exam Three.

Truck Weigh Station

Case Problem ONE for Exam THREE

This is a Managerial Report and must be completed following the instructions and format that are given in the course syllabus. Your instructor will indicate how it is to be delivered.

Case: “Truck Weigh Station” (worth 10 points)

A company produces crushed limestone for the road construction industry. The rock is crushed in a quarry and then sent by trucks to the construction site. Each truck must be weighed before exiting the quarry. There is one weight scale. The trucks arrive at the weigh station and, if necessary, line up to be weighed on a first come, first-served (FIFO) basis. Truck arrivals are Poisson distributed with an average of 9 trucks per hour. The time needed to weigh each truck varies but is exponentially distributed with an average of 5 minutes per truck. The entire weighing operation is at a steady state rate. The weigh station does not have a practical limit on the parking space available nor on the number of trucks serviced. Thus the Single-Server Model with “infinite” calling population is valid here.

1. Manually calculate the answers to the following questions and clearly show your calculations on a separate page that you attach to your report.
 - a. *What is the average service rate per hour of the weigh station (i.e., the number of trucks that the station can weigh per hour)?*
 - b. *What is the average number of trucks in the queue (the waiting line) at the weigh station?*
 - c. *What is the average number of trucks in the entire queuing system?*
 - d. *What is the average number of minutes a truck waits to be weighed?*
 - e. *What is the average number of minutes a truck spends in the entire queuing system?*
 - f. *What is the probability that a truck will arrive at the weigh station and not wait?*
 - g. *What percent of arriving trucks would you expect to have to wait?*
 - h. *Company management has as a goal that a truck should spend on average 10 minutes or less in the entire queuing system. Is this goal being met? Explain*
 - i. *Run QM to confirm your calculations (module “Waiting Lines – M/M/1 (exponential service times)”) and correct any mistakes. Attach to your report the QM “Results” table.*

Case Problem ONE for Exam THREE, continued

2. A second weigh station, identical to the first, can be purchased and installed for an investment of \$135,000. Truck arrivals are still Poisson distributed with an average of 9 trucks per hour. The new station would have the same operating characteristics, including exponentially distributed service times with an average of 5 minutes per truck. Trucks would still form a single line and follow “first come, first served” servicing. Run this case on QM as a multiple-server with an “infinite” calling population (QM module item “Waiting Lines – M/M/s”). Print and attach the Results Table and use it to answer the following questions.
 - a. Company management has as a goal that a truck spend on average 10 minutes or less in the entire queuing system. *Would adding the second station meet this goal? Explain.*
 - b. *By how many minutes per truck would the “average time in the system” be reduced by using two weigh stations instead of one?*
 - c. Assume the operation runs 8 hours per day for 5 days per week. *On average, how many trucks per week are expected to arrive?*
 - d. Use your result from c. *On average, the time spent by all trucks at the weigh stations would be reduced by a total of how many minutes per week?*