Answers Chp 8:

7. a. MAX: −0.35A2 + 8.3A + 540 − 0.60B2 + 9.45B + 1108 − 0.47C2 + 11.0C + 850

ST 3 A + 2 B + 4 C ≤ 10,000

2 A + 4 B + 3 C ≤ 9,000

3 A + 4 B + 2 C ≤ 11,000

A, B, C ≥ 0

10. a. MIN (SQRT((17 - X)2 + (34 - Y)2) – 29.5)2

+ (SQRT((12 - X)2 + (5 - Y)2) – 4.0)2

+ (SQRT((3 - X)2 + (23 - Y)2) – 17.5)2

16. a. MIN 60\*(800/Q1 + 500/Q2 + 1500/Q3) + 0.25\*(300Q1 + 1100Q2 + 600Q3)/2

ST 300Q1 + 1100Q2 + 600Q3 ≤ 45,000

9Q1 + 25Q2 + 16Q3 ≤ 3,000

Q1 , Q2, Q3 ≥ 1 and integer

23. a. MIN 130\*((X-9)2+(Y-43)2)0.5 +75\*((X-2)2+(Y-28)2) 0.5

+90\*((X-51)2+(Y-36)2) 0.5 +80\*((X-19)2+(Y-4)2) 0.5

ST ((X-9)2+(Y-43)2)0.5 ≤ 50

((X-2)2+(Y-28)2) 0.5 ≤ 50

((X-51)2+(Y-36)2) 0.5 ≤ 50

((X-19)2+(Y-4)2) 0.5 ≤ 50

25. a. MIN 2(X1)2 - 1X1 + 15 + (X2)2 + 0.3X2 + 10 + ∑∑CijXij

ST X11 + X12 + X13 + X14 ≤ 600

X21 + X22 + X23 + X24 ≤ 600

X11+ X21 ≥ 300

X12+ X22 ≥ 250

X13+ X23 ≥ 150

X14+ X24 ≥ 400

Xij ≥ 0

where

X1 = X11 + X12 + X13 + X14

X2 = X21 + X22 + X23 + X24

Answers Chapter 13 (Queueing):

5. Use the M/M/s template in Q.xlsx with:

Arrival Rate = 10, Service Rate = 12, Number of Servers = 1.

a. 0.1667

b. 4.1667

c. 30 minutes

10. Use the M/M/s template in Q.xlsx with:

a. With Arrival Rate = 1 per hour, Service Rate = 1 per hour, Number of Servers = 1, the queue of trucks would increase endlessly.

b.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Crew Size** | **Lq** | **W (minutes)** | **1-P(0)** | **Hourly Cost** |
| 4 | 0.0833 | 20 | 0.25 | $95.67 |
| 3 | 0.1667 | 30 | 0.333 | $80.50 |
| 2 | 0.5 | 60 | 0.5 | $77.00 |

c. A crew size of 2 results in the lowest hourly cost for this operation.

11. Use the M/M/s template in Q.xlsx with:

Arrival Rate = 30 per hour, Service Rate = 20 per hour

a. Service rate = 1/3 per minute

b. Arrival rate = 1/2 per minute

c. The queue would become infinite.

d. Three servers are required to keep the waiting time for check out less than one minute.

13. Use the M/M/s template in Q.xlsx with:

Arrival Rate = 60, Service Rate = 24, Number of Servers = 3.

***Note***: We assume customers wait in a single queue for the next available teller.

a. 0.0585 hours or 3.51 minutes

b. 1/24=0.0417 hours or 2.502 minutes

c. If Servers = 4, average waiting time in queue drops to 0.0089 hours or approximately 32 seconds.

d. None. 1/24=0.0417 hours or 2.502 minutes.

14. Use the M/M/s template in Q.xlsx with:

Arrival Rate = 5 per hour, Service Rate = 60/8 = 7.5 per hour, Number of Servers = 1.

a. 0.3333

b. 0.2667 hours or 16 minutes

c. 2

d. $9\*2\*8 = $144 per day

e. Probably. The total labor cost of people using the machines would drop to $9\*0.75\*8 = $54. This amount, plus the $45 daily lease cost is less than $144. But this all assumes that the 2 people currently using or waiting to use the single copy machine have a more productive use for their time. If all they would do is sit at their desk and play computer games then it does not make sense to lease the additional copier to give them more time to play computer games.

18. Use M/M/s with Arrival Rate = 14 (per hour), Service Rate = 15 (per hour), one server.

a. 56 minutes

b. 13.07

c. 0.933

d. 93.33%

e. With 3 servers the probability of having to wait is 0.0767.

25. The purpose of this question is to make the point that the M/M/1 queue is just a special case of the M/G/1 queue.