INTERNATIONAL UNIVERSITY OF JAPAN

Public Management and Policy Analysis Program
Graduate School of International Relations

DCC5350 (2 Credits)
Public Policy Modeling
Spring 2016

Homework 5: Queueing Model (100 points)

Instruction: Please write down your student ID and name at the top of your answer. PLEASE handwrite. Download the Excel queueing template from the course Web page. Submit your answer to TA by 17:00 Friday, June 10.

- Organize your answer in the ascending order (1, 2, …) and use single column.
- You MUST always show your computation clearly. Otherwise, you may not get the full credits.
- Use at least four digits below the decimal point when calculating probabilities whose four digits are not zero, in order to avoid rounding errors. Adjust cell formats for probabilities in Excel so that you have 4 digits below the decimal point,
- You may not communicate (including written, verbal, gestural, any other communication) with others except for the instructor or TA to do this homework.
- Collaboration (cheating) is NOT tolerable. However, you may ask TA or other students only for "technical help" when using Excel.
- Do not wait until the last minute to do this homework.

Again, *DO NOT ASK your classmates to show their work. DO NOT SHOW your work to other classmates. You may not share any electronic file with your classmate.* Defend yourself by keeping your work in a safe place to avoid unintended cheating. Failure to comply with this rule will be considered academic dishonesty and misconduct. The penalties include sanctions up to and including expulsion from the university. I trust each of you implicitly but you should be aware IUJ's policy. If you need clarification regarding this issue, you may contact the instructor or OAA (ofcgsir@iuj.ac.jp).

Question 1 (10 points) Answer the following questions.

1.1 **(5 points)** Solve *a* and *b* of Q11.3 on page 479. Explain why.
1.2 **(3 points)** Solve *a*, *b*, and *c* of Q11.4 on page 479.
1.3 **(2 points)** Solve Q11.9 on page 480.

Question 2. (35 points) Read 11.4 (pp.445-448) and assume that there are on average 8 clients per day (8 hours) who visit a tech rep. who can serve 10 clients per day. The office hour of the technical representative is 8 hours (9:00-17:00). These assumptions are basically applied to question 2 through 4. Let us assume M/M/1/FCFS/∞/∞.

2.1 **(5 points)** Report the interarrival time and mean service time in hour.
2.2 **(5 points)** Calculate ρ and then explain its meaning substantively.
2.3 **(5 points)** Calculate L and L_q and then explain its meaning substantively.
2.4 **(5 points)** Calculate W and W_q and then explain its meaning substantively.
2.5 **(5 points)** Calculate P_7 and then explain its meaning substantively.

2.6 **(5 points)** Calculate P(n > 5) and then explain its meaning substantively.
2.7 **(5 points)** Calculate P(w_q > 4 hours) and then explain its meaning substantively.

Question 3. (30 points) Read 11.5 (pp.453-457). Use the Excel queueing template (available on the course Web page) but handwrite the result.

3.1 **(10 points)** Assume M/M/1/FCFS/∞/∞ and find out the maximum value of lambda (which, of course, will be determined by adjusting the number of machines assigned to each tech rep.) that makes the average waiting time in the system is smaller than two hours. Report the interarrival time in hour, ρ, L, L_q, W, and W_q.
3.2 **(5 points)** Assume M/G/1/FCFS/∞/∞ with .2 standard deviation. The new state-of-the-art equipment reduces the mean service time to 30 minutes per customer. Report the interarrival time in hour, ρ, L, L_q, W, and W_q.
3.3 **(5 points)** Assume M/D/1/FCFS/∞/∞. Report interarrival time in hour, ρ, L, L_q, W, and W_q.
3.4 **(10 points)** Compare performance indicators you obtained in Q2.1-Q2.4, Q3.1, Q3.2, and Q3.3. Which queueing system do you think is best in general? (Ignore the costs incurred and focus only on performance indicators). Tell me your reasoning.

Question 4. (25 points) Read 11.6 (pp.457-461). Suppose the interarrival time is 20 minutes and M/M/s/FCFS/∞/∞. Use the Excel queueing template (do not calculate manually) but handwrite the result.

4.1 **(5 points)** Find out the minimal number of server that makes L smaller than 2.5. Report ρ, L, L_q, W, and W_q. How would you like this queueing system?
4.2 **(5 points)** Find out the minimal number of server that makes P(W_q > 30 minutes) smaller than .01 percent. Report ρ, L, L_q, W, and W_q. How would you like this queueing system?
4.3 **(10 points)** Read 11.9 (pp. 473-476). Assume that unit opportunity cost of a customer is $350 per day (8 hours) and the unit cost of a server is $100 per day. Obtain L when the number of server changes from 4 to 10. Calculate the expected service cost, waiting cost (opportunity cost), and total social cost per day using Excel as shown in 11.9. Determine the optimal number of server. Tell me your reasoning.
4.4 **(5 points)** Draw a graph of the expected service cost, waiting cost, and total social cost using Excel as shown in Figure 11.17 on page 476.

Checklist.
1. Your answer sheet
2. Excel Worksheet for Question 3 (Modified Queueing template with Q4.2 answer added).
3. Excel Worksheet for Question 4.3 and the economic analysis graph for Question 4.4.

End of homework assignment 5.