INTERNATIONAL UNIVERSITY OF JAPAN

Public Management and Policy Analysis Program
Graduate School of International Relations

DCC5350 (2 Credits)
Public Policy Modeling
Spring 2017

Homework 5: Queueing Model (80 points)

Instruction: Please write down your student ID and name at the top of your answer. PLEASE handwrite. You may use the Excel queueing template from the course Web page. Submit your answer to TA by 18:00 Friday, June 9.

- You MUST always show your computation clearly. Otherwise, you may not get the full credits.
- Use at least four digits below the decimal point, if possible, in your probability calculation in order to avoid large rounding errors.
- You may not communicate (including written, verbal, gestural, any other communication) with others except for the instructor or TA to do this homework.

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 of IUJ's policy on plagiarism and cheating.

Question 1 (41 points) Download the Excel worksheet for raw data from the course Web page (ququeing_2017_data.xlsx). This data set includes clients' arrival time during 13:30-14:00 (30 minutes) in a city hall. Let us assume M/M/1/FCFS/∞/∞ (there is only one government employee in the city hall). The mean service rate μ is known as 15 per 10 minutes. Attach your Excel Worksheet for Q1.1 and Q1.2.

1.1 **(5 points)** Construct the frequency tables in column E and F. Count the number of clients who arrive in the system every 10 minutes (time period). Show me how λ (=14) is calculated.
1.2 **(7 points)** Get inter-arrival time in second using column B and C. Then show me how mean arrival time (1/ λ) is about 42 seconds using the Excel worksheet. Pay special attention to the formula in the cell C7. Show me how 42 seconds is equivalent to .07 time periods (10 minutes).
1.3 **(5 points)** Calculate ρ and then explain its meaning substantively.
1.4 **(3 points)** Calculate L and L_q using ρ (rho) only and then explain its meaning substantively.
1.5 **(5 points)** Calculate W and W_q using Little's formula and then explain its meaning substantively.
1.6 **(3 points)** Calculate P(n > 20) and then explain its meaning substantively.
1.7 **(3 points)** Calculate P(w_q > 10 minutes) and then explain its meaning substantively.
1.8 **(5 points)** Suppose the city hall replaces the government employee with a smart servant (automated civil service machine like a vending machine). The mean service time

remains unchanged. Now the queueing system becomes M/D/1/FCFS/∞/∞. Report ρ, L, L_q, W, and W_q using the queueing model template (Excel worksheet on the Web page).

1.9 **(5 points)** What did you learn from Q1.3, Q1.4, Q.1.5, and Q1.8? Do you think mayor's decision on the introduction of the smart servant is reasonable or do you think that citizens love the smart servant? Why and why not?

Question 2. (22 points) Read E 11.24 on page 482. The second guideline is modified as "At least 95 percent of the time, the number of customers in the system should not exceed six": P(n <= 6) >=.95. The third guideline is modified as "For at least 95 percent of the customers, the time spent in the system should not exceed three minutes." Use the queueing model template (Do not calculate performance indicators by yourself but simply read and report them from the template).

2.1 **(10 points)** Solve question *a*. Report ρ, L, L_q, W, and W_q and show me your reasoning.
2.2 **(6 points)** Solve question *b*. Report ρ, L, L_q, W, and W_q and show me your reasoning.
2.3 **(6 points)** Solve question *c*. Show me your reasoning to determine the minimum number of servers to satisfy all guidelines. Report ρ, L, L_q, W, and W_q of the model you choose.

Question 3. (10 points) Read 11.8 (pp. 469-470). Explain why a high utilization factor provides surprisingly poor performance for the system. What if servers are not machines but human beings?

Question 4. (7 points) Explain key characteristics (or assumptions) that Markov chain and queueing model share in particular regarding customers' arrival (data generation process).

Checklist.
1. Your answer sheet
2. Excel Worksheet for Q1.1 and Q1.2

End of homework assignment 5.