ISyE 3232A&B - Fall 2013

Homework 4

Due at the beginning of class on Thursday Sept. 19 / Friday Sept. 20

1. Next month's production at a manufacturing company will use a certain part for its production process. Assume that there is an ordering cost of \$1,500 incurred whenever an order for the part is placed and the part costs \$50 per liter. Due to short product life cycle, unused part cannot be used in following months. There will be a \$10 disposal charge for each part left over at the end of the month. If there is a shortage, the production process is seriously disrupted at a cost of \$100 per part short. Assume that the demand is governed by a discrete distribution with $\mathsf{Pr}(D = 500) = \mathsf{Pr}(D = 800) = 1/8$, $\mathsf{Pr}(D = 600) = 1/2$ and $\mathsf{Pr}(D = 700) = 1/4$.

   (a) What is the optimal order-up-to quantity?

   (b) Should we order parts when the initial inventory $x = 0, 300, 550, 700$? If yes, how many parts should we order?

   (c) Repeat (b) when there is an ordering cost of \$3,000 (instead of \$1,500) incurred whenever an order for the part is placed.

2. Consider a single server queue. Initially, there is no customer in the system. Suppose that the inter-arrival time of the first 15 customers are:

$$2, 5, 7, 3, 1, 4, 9, 3, 10, 8, 3, 2, 16, 1, 8$$

   In other words, the first customer will arrive in 2 minutes, and the second will arrive in $2+5$ minutes, and so on. Also, suppose that the service time of the first 15 customers are

$$1, 4, 2, 8, 3, 7, 5, 2, 6, 11, 9, 2, 1, 7, 6$$

   (a) Compute the average waiting time (the time customer spend in buffer) of the first 5 **departed** customers.

   (b) Compute the average system time (waiting time plus service time) of the first 5 **departed** customers.

   (c) Compute the average queue size during the first 20 minutes.

   (d) Compute the average server utilization during the first 20 minutes.

   (e) Does the Little's law of hold for the average queue size in the first 20 minutes?

3. We want to decide whether to employ a human operator or buy a machine to paint steel beams with a rust inhibitor. Steel beams are produced at a constant rate of one every 14 minutes. A skilled human operator takes an average time of 700 seconds to paint a steel beam, with a standard deviation of 300 seconds. An automatic painter takes on average 40 seconds more than the human painter to paint a beam, but with a standard deviation of only 150 seconds. Estimate the expected waiting time in queue of a steel beam for each of the operators, as well as the expected number of steel beams waiting in queue in each of the two cases. Comment on the effect of variability in service time.