The Friendly Neighbor Grocery Store has a single checkout stand with a full-time cashier. Customers arrive randomly at the stand at a mean rate of 30 per hours. The service-time distribution is exponential, with a mean of 1.5 minutes. This situation has resulted in occasional long lines and complaints from customers. Therefore, because there is no room for a second check-out stand, the manager is considering the alternative of hiring another person to help the cashier by bagging the groceries. This help would reduce the expected time required to process a customer to 1 minute, but the distribution still would be exponential.

The manager would like to have the percentage of time that there are more than two customers at the checkout stand down below 25%. She also would like to have no more than 5% of the customers needing to wait at least 5 minutes before beginning service, or at least 7 minutes before finishing service.

1. Using the Excel template for the M/M/1 model, calculate L, W, Wq, Lq, P0, P1 and P2 for the current mode of operation. What is the probability of having more than two customers at the checkout stand? Find the probability that the waiting time before beginning service exceeds 5 minutes, and the probability that the waiting time before finishing service exceeds 7 minutes.
2. Repeat the analysis for the new alternative being considered by the manager.
3. Which approach should the manager use to satisfy her criteria as closely as possible?

Hints: The arrival rate is given in customers per hour, so the service rate has to be changed to the same units. The average service time is 1.5 minutes per customer (and later 1 minute per customer), which will require taking the reciprocal and multiplying by 60 minutes per hour to obtain the right units. A goal is the probability of more than 2 at checkout below 0.25. The event “more than 2” is the complement of “2 or less”, so sum P0, P1 and P2 and subtract from 1. The other goals use P(W>t) and P(Wq>t). The stated goads involve 7 and 5 minutes and they will require conversion to fractions of an hour.