

Solutions to Problem 1.

a. M/M/12 with $\lambda = 5$ customers / minute and $\mu = \frac{1}{2}$ customers / minute

b. $\rho = \frac{\lambda}{s\mu} = \frac{5}{6} \approx 0.8333$

c. We want π_0 :

$$\pi_0 = \left[\left(\sum_{j=0}^{12} \frac{(\frac{5}{6}(12))^j}{j!} \right) + \frac{12^{12}(\frac{5}{6})^{13}}{12!(1-\frac{5}{6})} \right]^{-1} \approx 0.000036$$

d. We want w_q :

$$\begin{aligned} \pi_{12} &= \frac{10^{12}}{12!} \pi_0 \approx 0.0749 \\ \Rightarrow \ell_q &= \frac{\pi_{12}(\frac{5}{6})}{(1-\frac{5}{6})^2} \approx 2.2469 \text{ customers} \\ \Rightarrow w_q &= \frac{\ell_q}{\lambda} \approx 0.4494 \text{ minutes} \end{aligned}$$