

**1.**

$$\begin{aligned}\pi(0) &= \left(1 + \frac{a_1}{s_1} + \frac{a_1 a_2}{s_1 s_2} + \dots\right)^{-1} \\ &= \left(\sum_{i=0}^{\infty} \left(\frac{1/9}{4/9}\right)^i\right)^{-1} \\ &= \frac{3}{4} \\ \pi(4) &= \pi(0) \cdot \left(\frac{1}{4}\right)^4 = \frac{3}{1024}\end{aligned}$$

**2.**

If there is 9 people in the line then

$$P(T = 2n) = \left(\frac{1}{2}\right)^n \frac{(n-1)!}{9!(n-10)!}$$

If the line is operating in steady state, then the formula gives us

$$P(T = 2n) = a \cdot q(1-q)^{n-1} - (a-1) \cdot p_S(1-p_S)^{n-1} = \frac{1}{5} \left(\frac{5}{6}\right)^{n-1} - \frac{1}{5} \cdot \left(\frac{1}{2}\right)^n$$

$$\text{as } a = \frac{1-p_A}{1-p_S} = \frac{6}{5} \text{ and } q = \frac{p_S-p_A}{1-p_A} = \frac{1}{6}$$

**3.**

$$\lim_{t \rightarrow \infty} E(Q(t)) = \frac{r}{1-r} = \frac{3}{2} \implies \frac{\lambda_A}{\lambda_S} = r = \frac{3}{5} \implies \lambda_A = \frac{1}{5}$$

Hence,

$$\pi(i) = \frac{2}{5} \left( \frac{3}{5} \right)^i$$

and  $f_{T_C^{SS}}$  is a exponential distribution with mean  $\lambda_S - \lambda_A = \frac{2}{15}$

**4.**

We have that

$$\pi(0) = 1 - r = 1 - \frac{10}{30} = \frac{2}{3}$$

which means that  $\frac{2}{3}$  of the time, there is no job left in the buffer. And hence the printer only work  $\frac{1}{3}$  of the time. Hence, the expected total time left is  $500 \cdot 3 = 1500$