Arrival Queue to Wait
Poisson Distribution
with $\lambda = 3/\text{hr}$

Queue to Wait
M/M/s
With $\lambda = 3/\text{hr}$, $\mu = 4/\text{hr}$ and $s = 2$

If more than one waits, then $n = ?$

Servers
Exponential Distribution
$P(T < t) = 1 - e^{-\mu t}$
With $\mu = 4/\text{hr}$

Probability of more than two and less than five to arrive in two hours?

Probability of more than one waiting to be served?

Probability of taking between five and fifteen minutes to serve one?

What is the Total Hourly Operation Cost:
Arrival Queue to Wait
Poisson Distribution
with \( \lambda = 3/\text{hr} \)

\[ P(X = x) = \frac{\lambda^x e^{-\lambda}}{x!}, \ x = 0,1, \ldots \]

Probability of more than two and less than five to arrive in two hours?

\[ P(2 < X \leq 4) = P(X \leq 4) - P(X \leq 2) = P(X = 3) + P(X = 4) = \frac{6^3 e^{-6}}{3!} + \frac{6^4 e^{-6}}{4!} = 0.08924 + 0.1385 = 0.2231 \]

= POISSON (3,6, FALSE) + POISSON (4,6, FALSE)

Queue to Wait
M/M/s
With \( \lambda = 3/\text{hr}, \mu = 4/\text{hr} \) and \( s = 2 \)

If more than one waits, then \( n = ? \)

\[ n > 1 \rightarrow n \geq 2 \text{ in queue } + s \text{ of } 2 \rightarrow n \geq 4 \text{ in system} \]

Probability of more than one waiting to be served?

\[ P(n \geq 4) = 1 - P(n \leq 3) = 1 - (P_0 + P_1 + P_2 + P_3) \]

\[ P_0 = \frac{2\mu - \lambda}{2\mu + \lambda} \]

\[ P_n = \begin{cases} \left(\frac{(\lambda/\mu)^n}{n!}\right)P_0, & \text{for } n \leq 2 \\ \left(\frac{(\lambda/\mu)^n}{2(n-1)}\right)P_0, & \text{for } n > 2 \end{cases} \]

Servers
Exponential Distribution
With \( \mu = 4/\text{hr} \)

\[ P(T < t) = 1 - e^{-\mu t} \]

Probability of more than one waiting to be served?

Servers
Exponential Distribution
With \( \mu = 4/\text{hr} \)

\[ P(T < t) = 1 - e^{-\mu t} \]

Probability of taking between five and fifteen minutes to serve one?

\[ P(5 < T < 15) = P(T < 15) - P(T < 5) = EXPONDIST(15/60,4,TRUE) - EXPONDIST(5/60,4,TRUE) = 0.6321 - 0.2835 = 0.3487 \]

\[ = 1 - e^{-45/60} - (1 - e^{-45/60}) = e^{-45/60} - e^{-305/60} = 0.7165 - 0.3679 = EXP(-4 \times 5/60) - EXP(-4 \times 15/60) = \]

What is the Total Hourly Operation Cost:

Hourly Pay x s Servers + L x Hourly Penalty Cost=

\[ $100 x 2 + $1 x 60 \text{mins/hr} x 0.8727 \text{ (L)} = $252.36 \]