$$\boxed{P_m = \rho^m P_0} \qquad \boxed{\sum_{m=0}^{\infty} P_m = 1} \qquad \boxed{\rho < 1}$$

P_0 in terms of λ and μ:

$$\sum_{m=0}^{\infty} P_m = 1$$

$$\sum_{m=0}^{\infty} \rho^m P_0 = 1$$

$$P_0 = \left(\sum_{m=0}^{\infty} \rho^m\right)^{-1}$$

$$P_0 = \Big(\underbrace{1 + \rho^1 + \rho^2 + \cdots + \rho^m}_{GP}\Big)^{-1}$$

$$P_0 = \left(\frac{1}{1-\rho}\right)^{-1} = 1 - \rho$$

$$\boxed{P_0 = 1 - \frac{\lambda}{\mu}}$$

$E[N]$:

$$N = \sum_{m=0}^{\infty} m P_m = \sum_{m=0}^{\infty} m \rho^m P_0$$

$$N = \underbrace{(1-\rho)}_{P_0} \sum_{m=0}^{\infty} m \rho^{m-1} \rho^1$$

$$N = (1-\rho)\rho \underbrace{\sum_{m=0}^{\infty} m \rho^{m-1}}$$

$$N = (1-\rho)\rho \frac{d}{d\rho} \underbrace{\sum_{m=0}^{\infty} \rho^m}_{GP}$$

$$N = (1-\rho)\rho \frac{d}{d\rho}\left(\frac{1}{1-\rho}\right)$$

$$N = (\cancel{1-\rho})\rho \frac{1}{(1-\rho)^{\cancel{2}}} = \frac{\rho}{(1-\rho)}$$

$$\boxed{N = \frac{\lambda}{\mu - \lambda}}$$