Queueing Formulas (Poisson Arrival)

Summary of symbols

λ	Arrival rate per time unit.
μ	Service rate (1/service time).
N	Finite capacity of the line.
α	$\alpha = \left(\frac{\lambda}{\mu}\right)^{N+1}$
λ_e	Effective λ. $\lambda_e = \frac{\lambda - \alpha\mu}{1-\alpha}$; for $\lambda = \mu$: $\lambda_e = \frac{N}{N+1}\mu$.
σ	Standard deviation of service time.
P_0	Probability of no customers in system.
P_w	Probability of waiting for service.
L_q	Average number of customers in line.
L	Average number of customers in system.
W_q	Average time spent in line.
W	Average time spent in system.

Formulas

Value	Exponential Service			General Service
	One Server	Two Servers	Finite	
P_0	$1 - \frac{\lambda}{\mu}$	$\frac{2\mu-\lambda}{2\mu+\lambda}$	$1 - \frac{\lambda_e}{\mu}$	$1 - \frac{\lambda}{\mu}$
P_w	$\frac{\lambda}{\mu}$	$\frac{\lambda^2}{\mu(2\mu+\lambda)}$	$\frac{\lambda_e}{\mu}$	$\frac{\lambda}{\mu}$
L_q	$\frac{\lambda^2}{\mu(\mu-\lambda)}$	$\frac{\lambda^3}{\mu(4\mu^2-\lambda^2)}$	$L - P_w$	$\frac{\lambda^2\sigma^2+P_w^2}{2P_0}$
L	$\frac{\lambda}{\mu-\lambda}$	$\frac{4\mu\lambda}{4\mu^2-\lambda^2}$	$\frac{\frac{\lambda_e}{\mu-\lambda_e} - \alpha N}{1-\alpha}$ *	$L_q + P_w$
W_q	$\frac{\lambda}{\mu(\mu-\lambda)}$	$\frac{\lambda^2}{\mu(4\mu^2-\lambda^2)}$	$\frac{L_q}{\lambda_e}$	$\frac{L_q}{\lambda}$
W	$\frac{1}{\mu-\lambda}$	$\frac{4\mu}{4\mu^2-\lambda^2}$	$\frac{L}{\lambda_e}$	$\frac{L}{\lambda}$

* For $\lambda = \mu$: $L = \frac{N}{2}$.

$P_{\text{full}} = 1 - \frac{\lambda_e}{\lambda}$