Poisson & Exponential

M/M/1

① $\lambda = 1/\text{mean interarrival}$

② $\mu = 1/\text{mean service}$

③ $\rho = \lambda/\mu$

④ $\text{Idle} = P_0 = 1 - \rho$

⑤ $P_n = P_0(\rho^n)$

⑥ $L_s = \lambda/(\mu - \lambda)$

⑦ $L_q = \rho \cdot L_s$

⑧ $W_s = 1/(\mu - \lambda)$

⑨ $W_q = \rho \cdot L_q$

Exponential & Uniform

M/G/1

① $\lambda = 1/\text{mean interarrival}$

② $\mu = 1/\left(\frac{a+b}{2}\right)$

③ $\sigma^2 = (b-a)^2/12$

④ $\rho = \lambda/\mu$

⑤ $\text{Idle} = P_0 = 1 - \rho$

⑥ $P_n = P_0(\rho^n)$

⑦ $L_q = \frac{\lambda^2\sigma^2 + \rho^2}{2(1-\rho)}$

⑧ $W_q = L_q/\lambda$

⑨ $W_s = W_q + \frac{1}{\mu}$

⑩ $L_s = \lambda \cdot W_s$

Gamma & Normal

G/G/1

(1) $\lambda = 1/\text{mean interarrival}$

(2) $\mu = 1/\text{mean service}$

(3) $\sigma_a^2 = \text{Arrival Variance}$

(4) $\sigma_s^2 = \text{Service Variance}$

(5) $C_a^2 = \sigma_a^2/(1/\lambda)^2$

(6) $C_s^2 = \sigma_s^2/(1/\mu)^2$

(7) $\rho = \lambda/\mu$

(8) $\text{Idle} = P_0 = 1-\rho$

(9) $L_q = \dfrac{\rho^2(1+C_s^2)(C_a^2+\rho^2 C_s^2)}{2(1-\rho)(1+\rho^2 C_s^2)}$

(10) $W_q = L_q/\lambda$

(11) $W_s = W_q + 1/\mu$

(12) $L_s = \lambda . W_s$

Multiple Server Queues

Exponential & Uniform

M/G/C

1. $\lambda = 1/\text{mean interarrival}$

2. $\mu = 1\left(\frac{a+b}{2}\right)$

3. $\sigma_s^2 = (b-a)^2/12$

4. $C_a^2 = 1$

5. $C_s^2 = \sigma_s^2/(1/\mu)^2$

6. $\rho = \lambda/(c\mu)$

for (M/M/c) 7 to 9

7. $L_q^{M/M/c} = \frac{P_0(\lambda/\mu)^c \rho}{c!(1-\rho)^2}$

8. $P_0 = \frac{1}{\left[\sum_{m=0}^{c-1} \frac{(c\rho)^m}{m!} + \frac{(c\rho)^c}{c!(1-\rho)}\right]}$

for c = 2

$$P_0 = \frac{1}{\left[\frac{[(2)(\rho)]^0}{0!} + \frac{[(2)(\rho)]^1}{1!}\right] + \frac{(2\rho)^c}{2!(1-\rho)}}$$

(9) $W_q^{m/m/c} = \dfrac{L_q^{m/m/c}}{\lambda}$

For (G/G/c) (10) to (14)

(10) $W_q^{G/G/c} \approx W_q^{m/m/c} * \dfrac{C_a^2 + C_s^2}{2}$

(11) $L_q^{G/G/c} = W_q^{G/G/c} * \lambda$

(12) $W_s = W_q + \dfrac{1}{\mu}$

(13) $L_s = \lambda W_s$

W_q ↓ given in question ↓

(14) $|E_a| = \left| \dfrac{\text{Estimated value} - \text{Observed value}}{\text{Estimated value}} \right| \times 100$