



$A/B/s/K/N/D$

A = ARRIVAL PROCESS

B = SERVICE TIME DISTRIBUTION

s = NUMBER OF SERVERS

K = s + k = NUMBER OF PLACES IN SYSTEM

k = BUFFER SIZE

N = POPULATION

D = QUEUE'S DISCIPLINE

QUEUEING MODEL	$\rho$ (Expected Utilization)	$P_0$ (Probability of System Empty)	$P_n$ (Probability of System with n)
M/M/1	$\frac{\lambda}{\mu} < 1$	$1 - \frac{\lambda}{\mu}$	$\rho^n p_0$
M/M/s s=Number of Servers	$\frac{\lambda}{s\mu} < 1$	$\left[ \sum_{m=0}^{s-1} \frac{(s\rho)^m}{m!} + \frac{(s\rho)^s}{s!(1-\rho)} \right]^{-1}$	$\frac{(s\rho)^n}{n!} p_0$ if $1 \leq n \leq s$ $\frac{(s\rho)^n}{s!s^{n-s}} p_0 = \frac{\rho^n s^s}{s!} p_0$ if $n \geq s$
M/M/ $\infty$	$\frac{\lambda}{\mu}$	$e^{-\frac{\lambda}{\mu}}$	$\frac{\left(\frac{\lambda}{\mu}\right)^n}{n!} p_0$
M/M/1/K K=System Capacity	$\frac{\lambda}{\mu} < 1$	$\frac{1 - \frac{\lambda}{\mu}}{1 - \left(\frac{\lambda}{\mu}\right)^{K+1}}$	$\left(\frac{\lambda}{\mu}\right)^n p_0$ if $1 \leq n \leq K$
M/M/s/K K=System Capacity	$\frac{\lambda}{s\mu}$	$\left[ 1 + \sum_{m=1}^s \frac{\left(\frac{\lambda}{\mu}\right)^m}{m!} + \frac{\left(\frac{\lambda}{\mu}\right)^s}{s!} \sum_{m=s+1}^K \left(\frac{\lambda}{s\mu}\right)^{m-s} \right]^{-1}$	$\frac{\left(\frac{\lambda}{\mu}\right)^n}{n!} p_0$ for $n = 1, 2, \dots, s$ $\frac{\left(\frac{\lambda}{\mu}\right)^n}{s!s^{n-s}} p_0$ for $n = s+1, s+2, \dots, K$ 0 for $n > K$

QUEUEING MODEL	$\rho$ (Expected Utilization)	$P_0$ (Probability of System Empty)	$P_n$ (Probability of System with n)
<b>M/M/1/∞/N</b> <b>N=Population Size (Machine Repairman Model)</b>	$\frac{\lambda}{\mu}$	$\left[ \sum_{m=0}^N \rho^m \frac{N!}{(N-m)!} \right]^{-1}$	$\rho^n \frac{N!}{(N-n)!} p_0$ for $1 \leq n \leq N$
<b>M/M/s/∞/N</b> <b>N=Population Size</b>	$\frac{\lambda}{s\mu}$	$\left[ \sum_{m=0}^{s-1} \frac{N! \left(\frac{\lambda}{\mu}\right)^m}{(N-m)! m!} + \sum_{m=s}^N \frac{N!}{(N-m)! s! s^{m-s}} \left(\frac{\lambda}{\mu}\right)^m \right]^{-1}$	$\frac{N! \left(\frac{\lambda}{\mu}\right)^n}{(N-n)! n!} p_0$ for $n = 1, 2, \dots, s$ $\frac{N! \left(\frac{\lambda}{\mu}\right)^n}{(N-n)! s! s^{n-s}} p_0$ for $s \leq n \leq N$ 0 for $n > N$