Topic: Tutorial 4 M&S Date:

1) In single server queuing system, if $\lambda = 20$ and $\mu = 25$, what is utilization factor?

soln,

The probability that the server is busy (i.e. probability that customer has to wait) is called utilization factor i.e.

$$U = \frac{\lambda \text{ (arrival rate)}}{\mu \text{ (service rate)}}$$

$$= \frac{20}{25}$$

$\therefore U = 0.8$ # which is required utilization factor

2) Customers enter the waiting line at a cafeteria on a first come, first serve basis. The arrival rate follows a poisson distribution, while service time follows an exponential distribution. If average number of arrivals is 6/min and average rate of server is 10/min, what is average time a customer spends waiting in line for service?

Soln

given, $\lambda = 6$, $\mu = 10$

average time waiting for service $(W_q) = \frac{\lambda}{\mu(\mu - \lambda)}$

$$= \frac{6}{10(10-6)}$$

$$= 0.15$$

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Topic...Date.............................

3) customers enter the waiting line at a cafeteria on first-come first serve basis, the arrival rate follows a poisson distribution while service follows exponential distribution. If average arrivals ~~per~~ is 6/min and average service rate of single server is 10/min. what is average no. of customers in system?

soln,

given: $\lambda = 6$, $\mu = 10$,

average customer no. in system $(L) = \frac{\lambda}{\mu - \lambda}$

$= \frac{6}{10-6}$

$= \frac{6}{4} = 1.5$ #

average customer in waiting line is

$L_q = \frac{\lambda^2}{\mu(\mu-\lambda)} = \frac{6^2}{10(10-6)}$

$= 0.9$

4) which model/system applies deductive reasoning of mathematical theory to solve a model? ~~solve~~ support your answer.

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Topic...Date...............................

λ = arrival rate (av. no. of customers arriving / time period)

μ = service rate (av. no. of customers being served / time period by tellers)

1) Probability that no customers are in the queuing system (idle) is $P_0 = \left(1 - \frac{\lambda}{\mu}\right)$ (server idle)
↳ prob. that customer can be served is

2) Probability that n customers are in the system (busy):

$$P_n = \left(\frac{\lambda}{\mu}\right) \times P_0 = \left(\frac{\lambda}{\mu}\right) \times \left(1 - \frac{\lambda}{\mu}\right)$$

3) average number of customers in the queuing system (customers waiting and being served)

$$L = \frac{\lambda}{\mu - \lambda}$$

4) average customers in waiting line is

$$L_q = \frac{\lambda^2}{\mu(\mu - \lambda)}$$

5) average time customer spends in the total queuing system (waiting and being served)

$$W = \frac{1}{\mu - \lambda} = \frac{L}{\lambda}$$

6) average time a customer spends waiting in the queue to be served is

$$W_q = \frac{\lambda}{\mu(\mu - \lambda)}$$

7) utilisation factor $U = \frac{\lambda}{\mu}$

8) Prob that server is idle (customer can be served) = $1 - U$

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