Date:

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CS - 050
CSM Assignment # 3

Question #1.

$\mu = 4000 \text{ bps} = \frac{4000 \times 60}{8} = 30\,000$ char/min

$\lambda = 22000$ char/min

and $\mu = 4000 \text{ bps} = \frac{4000}{8} = 500$ char/sec

$\lambda = 22000 \text{ char/min} = \frac{22000}{60} = 366.67$ char/sec

a) $\rho = \frac{\lambda}{s\mu} = \frac{22000}{(1)(30000)} = 0.733$

$\rho = 0.733$ (utilization of the line)

b) $L_q = \frac{\lambda^2}{\mu(\mu-\lambda)} = \frac{(22000)^2}{(30{,}000)(30{,}000 - 22000)}$

$L_q = 2.0167$ (avg. # of char waiting to be transmitted)

c) $L = \frac{\lambda}{\mu-\lambda} = \frac{22000}{30000-22000} = 2.75$

$L = 2.75$ (avg. # of char on the system)

d) $W = \frac{L}{\lambda} = \frac{1}{\mu-\lambda} = \frac{1}{500-366.67} = 7.5$ mse

$W = 7.5$ msec (avg. char transmitted delay)

e) $W_q = \frac{L_q}{\lambda} = \frac{\lambda}{\mu(\mu-\lambda)} = \frac{366.67}{500(500-366.67)}$

$W_q = 5.5$ msec (avg. queing delay for each char)

f) $P_1 = \frac{\lambda}{\mu}(P_0) = \frac{\lambda}{\mu}(1-\rho) = \frac{366.67}{500}(1-0.733)$

$P_1 = 0.196$ (Prob that the char will be immediately transmitted)

Date:

g) $\because P_n = \frac{\lambda^n}{\mu^n}(1-\rho)$

So $P\{x \le 2\} = P_0 + P_1 + P_2$

$= (1-\rho) + \frac{\lambda}{\mu}(1-\rho) + \frac{\lambda^2}{\mu^2}(1-\rho)$

$= (1-0.733) + \frac{366.67}{500}(1-0.733) + \frac{(366.67)^2}{(500)^2}(1-0.733)$

$= 0.267 + 0.196 + 0.143$

$P\{x \le 2\} = 0.606$ (Prob. of atmost 2 chai in the system)

h) 90^{th} percentile $= W \log_e \frac{100}{100-r}$

$= \frac{1}{(\mu-\lambda)} \log_e\left(\frac{100}{100-90}\right) = \left(\frac{1}{(500-366.67)}\right)\log_e\left(\frac{100}{10}\right)$

$= (7.5\times10^{-3})(2.3025)$

90^{th} percentile waiting time in the system $= 0.0173$ sec

i) $= W_q \log_e\left[\frac{100}{100-r}\right] = (5.5)\log_e\left(\frac{100}{100-90}\right) = 12.66$ mse

It's the 90^{th} percentile waiting time in the queue.

Question #02

a) Avail:

Reason is that the system will be used non-stop and user expect a continuous service usage of this system all the time i.e 24 hours and value of matric is 0.9997 means system is available for 9997 tims out of 10000.

b) MTTF:

Reason is the system has longer transaction or osage time. the usage of this system according to prediction is 3 hours per day and value of metric is 300.

Date:

c) POFOD:
Reason is service demand will be at relatively long time and serious consequence, the system will made request 4 to 5 times a year and value will be 0.001.

d) ROCOT:
Reason is regular request will be made by system where its usage will be 20 request made in every 30 minutes and value of metric is 2/500.

Question # 03:

$T = 8$ hours (Mission time)
λ for system $A = 8/1000 \Rightarrow 0.008$ /hr
λ for system $B = 12/1000 \Rightarrow 0.012$ /hr
Reliability of system A and B by using -ve exponential.

$R_A = e^{-\lambda_A \times T} \Rightarrow e^{-0.008 \times 8} = 0.938$
$R_B = e^{-\lambda_B \times T} \Rightarrow e^{-0.012 \times 8} = 0.908$

Reliability of Sys A:-

$$R_s(t) = 1 - \prod_{i=1}^{2} (1 - R_i(t))$$

$$R_s(t) = 0.996$$

Reliability of Sys B:-

$r = 3 \quad n = 5$

Date:

$$R_s(t) = \sum_{k=r}^{n} \binom{n}{k} R^k(t)\left(1 - R(t)\right)^{n-k}$$

$$R_s(t) = \sum_{k=3}^{5} \binom{5}{k} (0.908)^k (1-0.908)^{5-k}$$

$$R_s(t) = \binom{5}{3}(0.908)^3(1-0.908)^2 + \binom{5}{4}(0.908)^4(1-0.908)^1$$

$$+ \binom{5}{5}(0.908)^5(1)$$

$$R_{s_B}(t) = 0.9931$$

Reliability of overall system :-

$$R_s = R_A \times R_B$$

$$R_s = 0.996 \times 0.9931$$

$$R_s = 0.9891$$