EEL 703(Computer Networks)
Tutorial Sheet No.1
Answers

Note: $\rho = \frac{\lambda}{\mu}$ (even for finite capacity system)

1. The system can be modeled as an $M/M/2$ queueing system

(i) $\frac{\lambda}{2\mu} < 1 \Rightarrow \frac{\lambda}{\mu} < 2 \Rightarrow$ maximum load of 2 Erlangs

(ii) $\frac{4\rho}{4-\rho^2},\ \rho = \frac{\lambda}{\mu}$

(iii) $\frac{4}{\mu(4-\rho^2)}$

(iv) No

2. The system can be modeled as an $M/M/S/S$ queueing system
$P_B = p_S = \frac{\rho^S}{S! \sum_{i=0}^{S} \frac{\rho^i}{i!}} \leq 0.02 \Rightarrow S = 26$
The Erlang-B formula is valid for $M/G/S/S$ as well. Hence $S = 26$ when service time follows Pareto distribution.

3. (i) $M/M/1$ model (ii) $\frac{lq}{\mu} < 1$ (iii) $\frac{1}{\mu - ql}$

4. P(new arrival is blocked and refused)$=(1-p)\frac{\rho^s}{1-p\rho}p_0$ where $p_0 = \left[\frac{1-\rho^s}{1-\rho} + \frac{\rho^s}{1-p\rho}\right]^{-1}$

5. (i) 0.025 sec (ii) 0.0125 sec

6. Let i denote the number of non-operative transmitters. Then:
(ii) $p_i = \frac{4!}{2^{i-1}(4-i)!}\left(\frac{\lambda}{\mu}\right)^i p_0,\ i = 1,2,3,4$ (iii) p_4

7. Let (i,j) denote i calls of type 1 and j calls of type 2 in the system. Then
(i) P(type 1 is blocked)$=p_{(2,0)} + p_{(0,1)}$ (ii) P(type 2 is blocked)$=p_{(1,0)} + p_{(2,0)} + p_{(0,1)}$

8. (i) ρ (ii)Blocking probability $= \frac{\rho}{1+\rho} \leq 0.01 \Rightarrow \rho = .0101$

9. (i) Delay in i^{th} queue $= T_i = \frac{1}{\mu - \lambda}$ (ii) Delay $= \frac{1}{m(\mu-\lambda)}$

10. Let S be the random variable denoting service time. In this case, S is a mixed type random variable. The distribution of S is given by: $P(S = 0) = p$ and $f_S(z) = (1-p)\mu e^{-\mu z}; z > 0$. Modeling the system by $M/G/1$ queue, the mean delay is:
$E(S) + \frac{\lambda E(S^2)}{2(1-\lambda E(S))}$ where $E(S) = \frac{1-p}{\mu}$ and $E(S^2) = \frac{2(1-p)}{\mu^2}$