Homework Set No. 9

ECE 642
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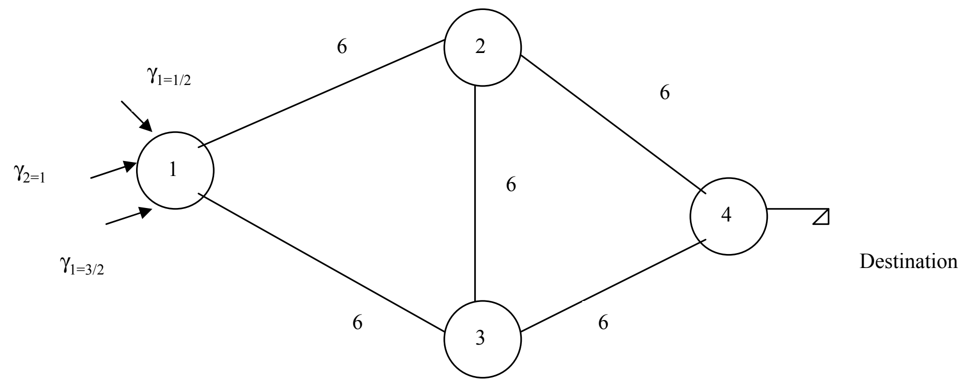
Problems 5.22,5.26,5.27,5.29&5.30 from M.Schwartz's book

Problem 1.

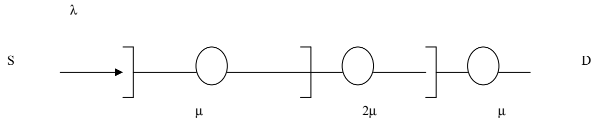
Consider the packet-switched network shown in figure below. Terminals 1,2 and 3 generate Poisson traffic at the rate of $\gamma_1 = 1/2$, $\gamma_2 = 1$ and $\gamma_3 = 3/2$ packets/sec respectively as shown. All packets are $1/\mu = 1/6$ sec long, on the average, exponentially distributed. All are destined for node 4, as shown. All line capacities are $\mu = 6$ packets/sec as shown.

- Find the average time-delay T from node 1 to node 4 if the packets go directly through node 2.
- Repeat a. if the packets follow the path $1 - 2 - 3 - 4$.
- Packets are now routed randomly through the network, from node 1 to node 4, with the following routing probabilities: $q_{13} = 1/3$, $q_{23} = 3/4$, $q_{34} = 1$. Find the average network-wide delay in this case.



Problem 2.

Consider the VC shown in figure below. A sliding window mechanism is used to control this VC. Use Buzen's algorithm to find the time-delay throughput characteristic for $\lambda \gg 2\mu$. Take $N = 1, 2, 3, 4, 5, 6$. Compare with the plot of delay vs throughput in case of a sliding window model.($M = 3, \ldots \infty$).Do the results agree with what you expect?



Problem 3.

Use Buzens algorithm to find the Nortons equivalent of an M-hop virtual circuit. Find $u(n)$ for various values of n and M and show that it is given by the expression $u(n) = n\mu/(n + M - 1)$. Show as a check that the average number of packets in each queue is n/M.

Problem 4.

Refer to the Figs.5-41 and 5-42.

- Let $N = 1$. Show that $P_B = \rho$ and $\gamma/\mu = \rho(1 - \rho)$. Sketch γ/μ as a function of ρ
- Let $N = 5$. Sketch γ/μ versus ρ and compare with the curve in Fig.5-42
- For any N, show that for $\rho^{'} = 1$, $\rho = N/(N + 1)$, $\gamma/\mu = (N/(N + 1))^2$. Show that for $\rho^{'} \to \infty$, $\rho \to 1$, $1 - P_B \to 1/\rho \to 0$ and $\gamma/\mu \to (1 - P_B) \to 0$. Show that for $\rho \ll 1$, $\gamma/\mu = \rho$. Can you use these values to sketch γ/μ versus ρ for any N? Compare with parts a and b above as well with the curve $N = 8$ in Fig.5-42.

Problem 5.

Refer to the section on input-buffer limiting. Take $N = 2$, $N_I = 1$, write and use simple computer program to solve for P_{B_T} and P_{B_I} interactively. Use this to find the average throughput $\gamma_1 = \lambda_1(1 - P_{B_I})$ as a function of load λ_I for serveral values of λ_I. Take $n = 2$, compare with the results of the previous problem. One possible procedure: Initialize with $P_{B_T} = P_{B_I} = 0$. Keep repeating until, at iteration $K + 1$, $\sqrt{(P_{B_T}^{K+1} - P_{B_T}^{K})^2 + (P_{B_T}^{K+1} - P_{B_I}^{K})^2} < \epsilon$ (a stopping constant). You can try any other initial values and stopping threshold.