Name: **ID:**

COE 444 - Internetwork Design and Management
Fall 2004 (Term 041)

Quiz 4

Date: Monday, December 27, 2004

Q1. (10 points) Suppose that 3 backbone switches (**A**, **B**, and **C**) are connected, in a tree structure, to each other with **100 Mbps** full duplex links. **A** is the root node of this tree. The average packet size has been estimated equal to **2000 bits**. It has also been observed that the traffic (in pps) generated by the various switches is Poissonian with rates as indicated in the following table:

Destination

Source	**A**	**B**	**C**
A	-	600	700
B	500	-	300
C	200	400	-

a. Find the internal traffic rate on link **AB** and **BA**, that is λ_{AB}, and λ_{BA}.

b. Find the utilization on link **AB**, that is ρ_{AB}.

c. Find the average delay suffered by a packet on link **AB**, that is Tr_{AB}.

d. Find the average number of items waiting and being served on link **AB**, that is r_{AB}.

e. Assume that the external traffic from all switches is multiplied by a constant factor **α**. What is largest value α_{max} that will cause the link **AB** to saturate?

Name: **ID:**

Q2. (8 points) For the tree network in question **Q1.**, assume that the MTBF and MTTR of any link are respectively 100 days and 1 day, and the MTBF and MTTR of any switch are respectively 100 days and 2 days.

a. Find P_l and P_s, the links and switches reliabilities.

b. Find the overall network reliability, that is, the probability that the network is connected.

c. Find ***E(A)***, the expected number of nodes communicating with the root node ***A***. Recall that, for any node i:

$$E(i) = P_i \times (1 + \sum_{k \in Succ(i)} P_{j_k} E(k))$$

where j_k is the link between node ***i*** and its successor node ***k***.

d. Find ***EPR(A)***, the expected number of node pairs communicating through the root node ***A***. Recall that,

$$EPR(A) = \sum_{\substack{i,k \in Succ(A) \\ i \neq k}} P_A P_{j_i} E(i) P_{j_k} E(k) + \sum_{i \in Succ(A)} P_A P_{j_i} E(i)$$

where P_{j_i} and P_{j_k} are respectively the reliabilities of the links between nodes ***i*** and ***k*** and the root ***A***. P_A is the reliability of switch ***A***, and ***E(i)***, ***E(k)*** are as defined above.

Q3. (2 points) List the four models defined by the OSI network management standard.