EC-305 Communication Systems

Sept. 2009 **Tutorial #2** KG / IITM

1. Referring to the Tutorial #2 of year 2008 (also enclosed), answer the following questions:
(a) Framing: Problems 1,2, and 3
(b) Switching: Problems 8,9,10, and 11
(c) Erlang-B formula application: Problems 13 and 14

2. For the switch considered in Problem 8 (in tutorial #2 of year 2008), use the blocking probability expression following the work of Jacobaeus (which does not assume that the paths from input-to-middle stage and paths from output-to-middle stage are independent) given in eqn. (5.10) in page 239 of the book. What will be the new value of k for this case?

3. Consider a population of N=4000 users, each of E_u=0.01 Erlangs. Design a 3-stage blocking switch of least complexity such that the blocking probability $P_b=10^{-4}$ or less. What is k, and the total number of cross-points for this switch? ***Hint:*** To minimize the total number of cross-points, choose the input sub-array dimension n "appropriately" where $N/m=n$.

4. Consider the 5-stage switch in the book, first described in page 237, Fig. 5.9. Here, blocking is introduced also in the middle stage(s). The input has N/n_1 sub-arrays, each of dimension n_1x k_1, where N is the total population to be served by this switch. The middle-stage (which is actually a blocking switch with 3-stages) has k_1 sub-arrays, each of size N/n_1x N/n_1. Each of these sub-arrays has $N/(n_1$x $n_2)$ sub-arrays, of dimension n_2xk_2 where k_2 is the number of middle stage sub-arrays (each of dimension $N/(n_1$x $n_2)$ x $N/(n_1$x $n_2)$). Assume each user offers E_u Erlangs of traffic.

(a) Prove using the Lee-Graph approach that blocking probability of the 5-stage switch is given by

$$P_b = \left\{1 - q_1^2\left[1-(1-q_2^2)^{k_2}\right]\right\}^{k_1} \text{ where } q_1 = (1-p_1) \text{ with } p_1 = \frac{n_1 E_u}{k_1} \text{ and } q_2 = (1-p_2) \text{ with } p_2 = \frac{n_2 p_1}{k_2}.$$

(b) For N=50,000, and n_1=50 and n_2=50, find the 5-stage switch with minimum number of cross-points so that $P_b=10^{-8}$ or less. Assume E_u = 0.01 Erlangs each.
(c) Can you find a better choice of n_1 and n_2 for this case? (i.e., a choice that will minimize the number of cross-points further?)

5. From "Digital Telephony" J.C.Bellamy, 3rd Ed., **Reading --** (a) Chapter 4: Framing in TDM; pp. 207 to 219, and (b) Chapter 5: Switching; pp. 225 to 261.