Name ______________________________

Interconnection Networks
EE 7725
Midterm Examination

19 October 1994,   13:40-14:30 C. D. T.

Problem 1	________	(35 pts)
Problem 2	________	(35 pts)
Problem 3	________	(30 pts)
Exam Total	________	(100 pts)

Good Luck!

Problem 1: Consider three requests for an $(n, m, m^{n-1}, \mathrm{S}, \mathrm{T})$ omega network: request $A = (a, \alpha)$, request $B = (b, \beta)$, and request $C = (c, \gamma)$. Requests B and C are given, request A is to be chosen so that: requests A and B pass through the same cell in stage x, and requests A and C pass through the same cell in stage y. (For $0 \leq x < y < n$.)

(a) For certain values of B and C it will be impossible to choose request A. Describe those values. (The answer should look something like $b_{(0)} \neq \sqrt{2\pi(a_{(0)} + c^2_{(x)})}$ or $b_{(1)} \neq \ldots$) *Hint: Find the path through the network taken by each request.* (7 pts)

(b) Find a request A in terms of B, C, x, and y. In terms of x, y, and n, how many ways can A be chosen? (18 pts)

(c) For a banyan network, why is it impossible to find three requests A, B, and C, where: requests A and B pass through the same cell in stage x, requests A and C pass through the same cell in stage y, and requests B and C pass through the same cell in stage z, (for $0 \leq x < y < z < n$)? (10 pts)

Problem 2: A k-ary n-cube network has nodes with d-slot queues at crossbar inputs, as shown below.

The traffic entering the input queue (from the PE) at each node is described by $(\mathrm{Bern}(\lambda), 1, \mathrm{Uni}(k^n - 1))$. (The destination distribution is $\mathrm{Uni}(k^n - 1)$ because a message starting at PE i cannot be destined for PE i.) The network is to be analyzed with a technique similar to Yoon's analysis of finite-buffered banyan networks.

Find expressions for the arrival and service rates for the input and link queues. (The expressions do not have to be solved or simplified. You do not have to complete Yoon's iterative analysis.) (35 pts)

Problem 3: Answer all of the questions below. Be as brief and as specific as possible.

(a) Write an equation for the probability of queue occupancy, $p(i)$, in an $(n, 2, 2^{n-1}, \mathrm{S}, \mathrm{T})$ omega network using one-slot queues. Use the non-iterative analysis, but modify it for local flow control. (10 pts)

The unmodified equation is

$$p(i) = p(i)(1 - v_i) + (p(i)v_i + 1 - p(i)) \left[1 - \left(1 - \frac{p(i-1)}{2} \right)^2 \right].$$

(b) Find a path from node 58 to 217 in a $(5, 4)$ deBruijn network and a $(5, 4)$ k-ary n-cube. For the deBruijn network, the path should be of length 2. List the nodes on each path. (10 pts)

(c) A low-cost parallel computer could use either a bus or a direct network (for example a ring). Name an advantage of a bus over a direct network for a low-cost system. Also, name an advantage of a direct network over a bus for a low-cost system. (10 pts)