Name ______________________

Interconnection Networks
EE 7725
Midterm Examination

27 October 1997, 16:00–16:50+ C. S. T.

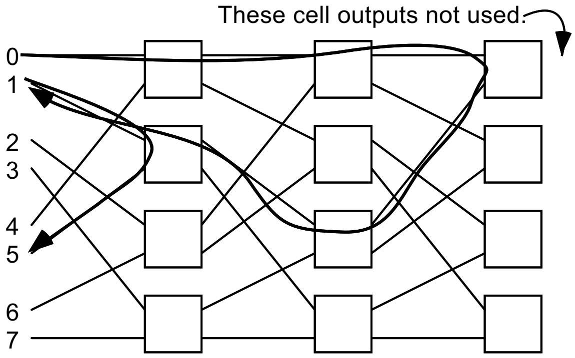
Modified

Problem 1	______	(40 pts)
Problem 2	______	(30 pts)
Problem 3	______	(30 pts)
Exam Total	______	(100 pts)

Alias ______________________

Good Luck!

Problem 1: An (m,n) two-way omega network is constructed from an (m,n) omega network by eliminating outputs, adding two-way capability to all links, and allowing cells to connect their outputs (or what were their outputs in ordinary omega network cells) to their inputs and to connect any of their inputs to any of their outputs or inputs (reversing direction). What were inputs in an ordinary omega serve as both inputs and outputs in the two-way omega. Two paths in such a network are illustrated to the right:



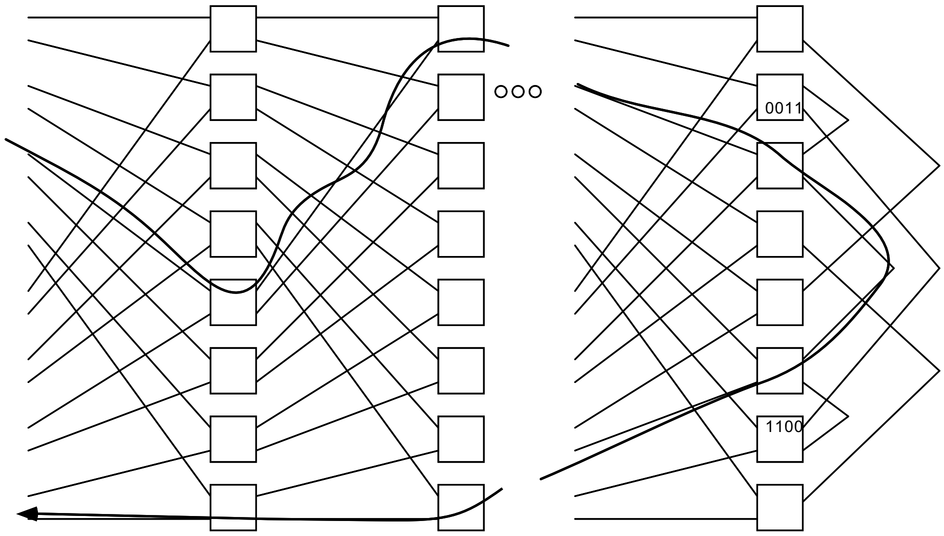
(a) What is the cost of an (m,n) two-way omega network in crosspoints (using crosspoints that can pass a signal in one direction only)? (10 pts)

(b) Find the cells on a shortest path from 12316_7 to 16416_7 in a (7,5) two-way omega network. Be sure to indicate the stage numbers. (10 pts)

(c) Assuming a path can change direction exactly once (as the ones illustrated above do), how many paths are there between 12316_7 and 16416_7? (10 pts)

Problem 1, continued.

(d) Suppose the cell outputs in the last stage of an (m, n) two-way omega were connected to each other by a digit reverse permutation (ρ), as illustrated below. What would be the minimum number of stages needed (so that there is at least one path between every pair of terminals)? Justify your answer. (10 pts)



Problem 2: The *degenerate cube* is constructed from a k-ary n-cube by adding links between every pair of nodes that lie along a dimension that are not already connected. (Not just those at distance $k/2$, as in a crumpled cube.)

(a) Provide a graph definition of the degenerate cube. (8 pts)

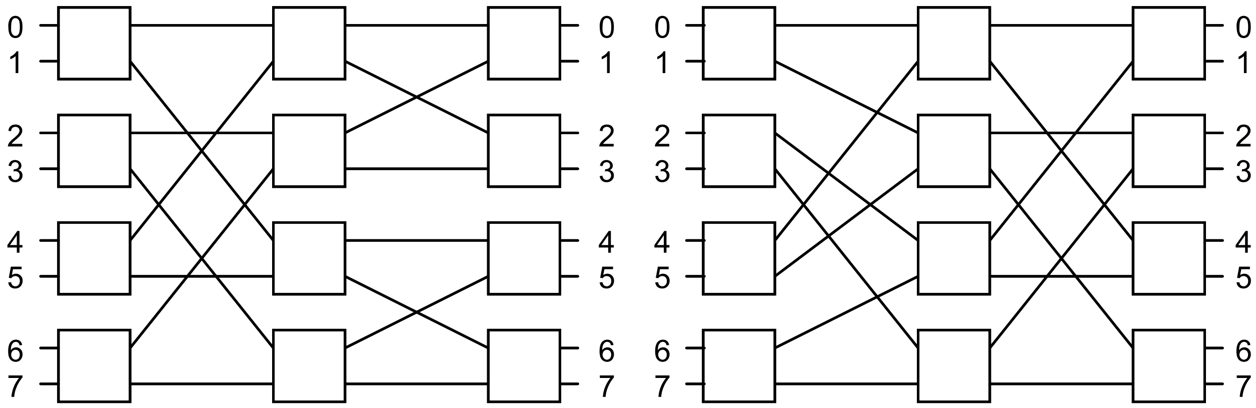
(b) Find expressions for the degree and diameter of the degenerate cube. (8 pts)

(c) Find an expression for the average distance in the degenerate cube. The expression need not be simplified. (7 pts)

(d) Compare a degenerate cube with and without dimension-order routing to a de-Bruijn network with respect to the number of shortest paths for a request. Under dimension-order routing, which is better, taking into account the difference in cost? (7 pts)

Problem 3: Answer each question below, be sure to properly justify each answer.

(a) Determine whether the two networks below are terminal equivalent and whether they are topologically equivalent. (8 pts)



(b) As seen in class, deadlock in a N-ary 1-cube (the ring) can be avoided by dividing (most) links into two virtual channels, one for use by messages with lower destination numbers (than the current node) and the other for messages with higher destination numbers (remember?). Suppose in a de-Bruijn network links were one way (messages could use shuffle exchange links but not exchange inverse shuffle links), each link was divided into two virtual channels, one ascending and one descending, and messages were restricted to one of these channels based on their destinations. Is such a routing scheme deadlock free? If not, show an example of deadlock. (8 pts)

(c) Does the Moore bound prove that a network with the de-Bruijn network's degree, diameter, and number of nodes exist?[1] Explain. (7 pts)

(d) Consider two systems having N processors running a total of P tasks as described by the multithreaded system model. The network in system A suffers occasional congestion, while the congestion level in the network in system B is steady throughout a run (for a given amount of traffic it's always congested or it's always not congested). The systems are otherwise identical. Suppose for a certain number of tasks both systems have the same utilization, and it's less than one, A suffers occasional congestion and B suffers moderate but steady congestion. For which system might increasing the number of tasks be more worthwhile? (7 pts)

[1] Just because a question is asked during review doesn't mean that it won't appear on the exam. For the record, the exam was made up before the review.