Name _____

Interconnection Networks
EE 7725
Midterm Examination

29 October 1996, 18:40–19:40 C. S. T.

Problem 1 _____ (35 pts)

Problem 2 _____ (35 pts)

Problem 3 _____ (30 pts)

Alias _____ Exam Total _____ (100 pts)

Good Luck!

Problem 1: A $k \times k$ *double mesh* network is defined by

$$\begin{aligned} V =& \{\, 0, 1, \ldots, k^2 - 1 \,\} \\ E =& \{\, (i,j) \mid i \in V,\ x \in \{0,1\},\ i_{(x)} < k-1,\ j = i + k^x \,\} \cup \\ & \{\, (i,j) \mid i \in V,\ i_{(0)} < k-1,\ i_{(1)} < k-1,\ j = i + 1 + k \,\} \cup \\ & \{\, (i,j) \mid i \in V,\ i_{(0)} < k-1,\ i_{(1)} > 0,\ j = i + 1 - k \,\}, \end{aligned}$$

where $i_{(x)}$ is digit x in the radix-k representation of i.

(a) Draw a 4×4 double mesh network. (9 pts)

(b) What are the degree and diameter of a $k \times k$ double-mesh network? (8 pts)

(c) Give a formula for $d_{i,j}$, the distance between $i, j \in V$. (9 pts)

(*d*) Show all turns (as in the turn model) possible in this network. (9 pts)

Problem 2: For $n > 1$ an n-stage, $m \times m$ *double-shuffle network* is an m^n-input network consisting of n identical stages, each having a $\sigma_{m^2, m^{n-2}}$ link pattern followed by m^{n-1} cells of size $m \times m$. (The structure is similar to the omega network.)

(a) Find the sequence of cells and links taken by request $(11706, 14151)$ in a 5-stage, 7×7 double-shuffle network. Note, $11706_{10} = 46062_7$ and $14151_{10} = 56154_7$. (20 pts)

(b) Find a mapping function for the inputs and stage-0 cells from an n-stage, $m \times m$ double-shuffle network to an n-stage, $m \times m$ omega network, where $n > 1$. The mapping function should show that the two networks are topologically equivalent *up to and including the first stage.* (8 pts)

(c) Show that the double-shuffle network is not topologically equivalent to an n-stage, $m \times m$ omega network, where $n > 1$. *Hint: this can easily be solved without mapping functions.* (7 pts)

Problem 3: Answer each question below.

(a) Find the shortest path from node 0123456 to 0564123 in a $10, 7$ de Bruijn network. (7 pts)

(b) Describe a situation in which a linear network is better than a bus and another situation in which a bus is better than a linear network. Ignore cost. (7 pts)

(c) The Moore bound is derived by constructing a tree. Does the diameter of that tree meet the Moore bound? Explain. (7 pts)

The paragraph below applies to the two following parts.

When applied to k-ary n-cubes, both the link-length bound and the fixed-bisection-width analysis suggest that smaller n is better.

(d) Explain how small-n KNC's are shown to be superior using each method. (Do not explain how the method works, but describe what happens in a large-n KNC that's bad [or a small n-KNC that's good] as revealed by each method.) (6 pts)

(e) Are the two advantages of small-n KNC's discussed above orthogonal? (Roughly speaking, two things are orthogonal if they are different. For example, two orthogonal advantages of living in Louisiana are good food and good music. Two advantages of living in Louisiana that are not orthogonal are good music and good Jazz, since Jazz is a kind of music.) (3 pts)