

FINAL EXAM (12/6/96)
COP 6617 Distributed System Design
Open books and notes

Name _____ SSN _____

1. (30 pts) Design a **distributed and minimal broadcast algorithm** for extended meshes (EM) (see page 207). To simplify the broadcasting algorithm, we assume that the source is the lower-left corner node.
 - Demonstrate your approach by drawing a **minimal spanning tree** on a 7×7 extended mesh rooted at the lower-left corner node.
 - Your distributed broadcasting algorithm should include the following two parts: one for the source node and another one for intermediate nodes.

2. (30 pts) Using Glass and Ni's Turn model, we can divide the routing space of a 2-D mesh into four regions (relative to the location of the source): NE, SE, NW, SW. For a particular Turn model (such as West-First), it is fully adaptive in some region(s), partially adaptive in other region(s), and nonadaptive in the remaining region(s). Two Turn models A and B are said to be **complement** to each other, if in any region, either A or B (or both) is fully adaptive.
 - Determine a complement of the West-First Turn model.
 - Demonstrate the correctness of your result by showing routing adaptivity of these two Turn models in each region.

3. (20 pts) Suppose we use the following implementation of the two-phase locking scheme for each transaction: place a lock just before the corresponding object is needed and unlock the object immediately after it has been used, provided all objects have been locked. When there are several unlocks that can be placed at the same time, the placement is based on the lock time of each object, i.e., the object that is locked first should be unlocked first. Apply this approach to the example on pages 390 and 391. Show all the possible serializable schedules generated from this implementation.

4. (20 pts) Consider a 4-level tree in which each intermediate node has exactly five children. A total of 125 leaves are in the tree. The 4-level tree can be considered as three levels of clusters of 2-level overlapping trees (see the example on page 401 with two levels of clusters).

- Determine the read and write quorum for the following cases.
 - $w = 3$ and $r = 3$ for all the clusters.
 - $w = 3$ and $r = 3$ for the clusters at the first and last levels, and $w = 4$ and $r = 2$ for the clusters at the the middle level.
- Compare the above results with the ones for 125 replicas that are linearly organized and provide your conclusions.