CS 603 (Park) **Assignment V** **Due: Feb. 28 (Fri.), 1997**

PROBLEM 1

Give a proof of why a concurrent system implementing two-phase locking with *canonical lock ordering* is deadlock free. (*Hint: There are several ways of proving this. Come up with your own proof from first principles; do not look up a proof from other sources.*)

PROBLEM 2

Consider the leader election algorithm for ring networks (physical or logical) discussed in class. Modify the algorithm such that it works in a *noncooperative* environment where at most one node is assumed to be malicious. Show that your distributed algorithm, under a single failure, eventually converges to a steady-state where all alive nodes, except for the malicious node, reach consensus on who the new leader is.

PROBLEM 3

Give a proof sketch of Eswaran et al.'s theorem which states that in a transaction system implementing two-phase locking all schedules formed by interleaving are serializable. You may assume that there are n transactions and m locks for m shared variables. (*Hint: Make precise the "transformation" method discussed in class. I.e., given an interleaved schedule obeying two-phase locking, show how it can be transformed, step-by-step, without changing the result, such that it is equivalent to a permutation schedule. Craft your own proof and do not look up answers from other sources.*)

PROBLEM 4

Given k storages each with failure rate ε, show how a stable storage can be devised which has failure rate $O(\varepsilon^k)$. What assumptions on the update/copy cost does one need to make?