5. Exercise sheet: Distributed Concurrency Control and Recovery

Exercise 1
Assume a given set of transactions and let $SR$ be the set of all serializable schedules on a centralized database. Let $2PL$ ($TS$) be the set of all schedules when applying a 2-phase locking (time stamp protocol). Which of the following statements are correct? Give proofs or counterexamples.

- $SR = TS$
- $SR = 2PL$
- $SR = 2PL \cup TS$
- $2PL = TS$
- $2PL \subseteq TS$
- $TS \subseteq 2PL$
- $TS \cap 2PL = \emptyset$

Exercise 2
Prove that distributed 2PL guarantees serializability.

Exercise 3
Consider the following local schedules:

- $S_1 : R_1 A \ W_1 A \ R_2 A \ W_2 A$
- $S_2 : R_2 B \ W_2 B \ R_1 B \ W_1 B$
- $S_1 : R_1 A \ W_2 A$
- $S_2 : R_3 B \ W_1 B \ R_2 C \ W_3 C$
- $S_1 : R_1 A \ R_3 A \ R_3 B \ W_3 A \ W_3 B \ R_2 B$
- $S_2 : R_4 D \ W_4 D \ R_1 D \ R_2 C \ R_4 C \ W_4 C$
- $S_1 : W_1 A \ c_1 \ R_3 A \ R_3 B \ c_3 \ W_2 B \ c_2$
- $S_2 : W_2 C \ c_2 \ R_4 C \ R_4 D \ c_4 \ W_1 D \ c_1$

(1) Verify whether or not the schedules are serializable.
(2) Demonstrate that by applying Distributed 2PL (Timestamp Protocol) the not serializable schedules could not have occurred.
(3) Check whether or not the schedules are rigoures and commit-deferred.
(4) Demonstrate that by applying a Ticket-based concurrency control the not serializable schedules could not have occurred.
Exercise 4
(1) Give the communication topology of centralized, decentralized and linear 2PC.
(2) Give the state diagrams of decentralized and linear 2PC, in analogy to the state diagram of centralized 2PC.

Exercise 5
Characterize centralized 2PC and linear 2PC with respect to
(1) message and time complexity,
(2) possibilities of processes to become uncertain.