ACID

• **Atomic** - Transactions are indivisible. No intermediate values are seen
• **Consistent** - The transactions always leave the system in a consistent state
• **Isolated** - One transaction does not affect another. Serially equivalent
• **Durable** - Once committed, the change is permanent
Two phase locking

- Method of concurrency control.
- No new locks are acquired after a lock is released.
- All interleaving of parallel transactions using two phase locking are serializable.
Strict Two Phase Locking

- Once a lock is acquired, it is kept until the end of the transaction.
- All locks are released at the end of the transaction.
- Simple for the transaction
- Objects are locked when accessed and released at termination
Timestamp Ordering

• An alternative to locking.
• Each transaction has one unique timestamp based on when the transaction starts. This timestamp does not change.
• A transaction is aborted if it might interfere with another or generate inconsistencies.
• There is no locking and no deadlocks.
Pessimistic Timestamp Ordering

• All data items have read and write timestamps.
• Data timestamps are set to the transaction’s timestamp when read or written.
• A transaction is aborted if it accesses data that has been accessed by another transaction since the first transaction started.
Read Rules

- If a transaction attempts to read data whose write timestamp is greater than the transaction timestamp, the transaction is aborted.
- Otherwise the read occurs and the data read timestamp is updated if it is less than the transaction timestamp.
Write Rules

• If a transaction attempts to write data whose read timestamp is greater than the transaction timestamp, the transaction is aborted.

• Otherwise the write occurs (tentatively) and the data write timestamp is updated if it is less than the transaction timestamp.
Optimistic Timestamp Ordering

• Don’t check for problems during a transactions execution.
• At the end, abort the transaction if any accessed data item has been changed since the transaction started.
• Works well if interference is unlikely.