

Endsem Review: Solutions

1.
 - (a) Yes, this is a spin lock (test and test and set lock).
 - (b) When a node tries to acquire a lock already held, it gets a copy of the lock variable in shared state in its cache.
 - (c) When a thread releases the lock and changes its value to 0, the cached copies in all other cores are invalidated and all cores read the new value. Once other threads on other cores realize that the lock is free, they all perform test and set, causing the cache line to bounce across cores. Eventually, once some thread acquires the lock, all the other contending threads realize that their test and set has failed, and go back to waiting on the read-only copy of the lock variable.
 - (d) No cache coherence traffic is generated during the wait period.
2.
 - (a) $x = 4$ and $y = 4$ since the write must be immediately reflected with strict consistency.
 - (b) $x = 1$ and $y = 2$.
 - (c) The value of x can be 0 or 1, and the value of y can be 0 or 2, because the writes can be applied in any order. However, the values returned by any replica will be the same.
 - (d) Same as above, except different replicas can return different values.
3.
 - (a) The stack has c, b, a, aa, aaa.
 - (b) After thread 3 runs, the stack has c, a, aa, aaa. After thread 2 runs, the stack (incorrectly) has b, a, aa, aaa. This is an example of the ABA problem, where the CAS statement in thread 2 gets stale pointers but does not detect the problem, because the top variable is the same.
 - (c) This scenario does not result in the ABA problem because top has changed. The stack correctly has b, aa, aaa.
4.
 - (a) Follower (a) was lagging behind the current leader in term 6, and missed term 7. It would have voted for the leader.
 - (b) Follower (b) was lagging behind since term 4. It would have voted for the leader.
 - (c) Follower (c) has more updates in term 6. It would not have voted for the new leader as it has a more up-to-date log.
 - (d) Follower (d) was probably the leader in term 7, but crashed before replicating any entries. It would not have voted for the new leader. But now that the new leader has no record of term 7, all the term 7 entries will be rolled back.
 - (e) Follower (e) is similar to follower (b).
 - (f) Follower (f) was probably the leader in terms 2 and 3 but failed to replicate its entries. All its old entries from terms 2 and 3 will be rolled back.