Homework 4 (20 points)
Due 04/25/19 at the beginning of class

1 (6 points) A server manages the objects $a_1, a_2, ..., a_n$. The server provides two operations for its clients: (1) $read(i)$ returns the value of $a_i$ and (2) $write(i, \text{Value})$ assigns $\text{Value}$ to $a_i$. Consider two transactions $T$ and $U$ defined as follows:

$T$: $x = read(j); y = read(i); write(j, 44); write(i, 33)$;

$U$: $x = read(k); write(i, 55); y = read(j); write(k, 66)$,

Give serially equivalent interleavings of $T$ and $U$ with the following properties:
(a) that are strict;
(b) that are not strict but could not produce dirty reads;
(c) that could produce dirty reads.

2 (4 points) Explain why serial equivalence requires that once a transaction has released a lock on an object, it is not allowed to obtain any more locks. Illustrate your answer with the following transactions $T$ and $U$ at the server in Problem 1:

$T$: $x = read(i); write(j, 44)$;

$U$: $write(i, 55); write(j, 66)$.

Describe an interleaving of $T$ and $U$ in which locks are released early with the effect that the interleaving is not serially equivalent.

3 (5 points) A three-phase commit protocol has the following parts:

Phase 1: Is the same as for two-phase commit.

Phase 2: The coordinator collects the votes and makes a decision; if it is \textit{No}, it aborts and informs participants that voted \textit{Yes}; if the decision is \textit{Yes}, it sends a \textit{preCommit} request to all the participants. Participants that voted \textit{Yes} wait for a \textit{preCommit} or \textit{doAbort} request. They acknowledge \textit{preCommit} requests and carry out \textit{doAbort} requests.

Phase 3: The coordinator collects the acknowledgments. When all are received, it \textit{commits} and sends \textit{doCommit} to the participants. Participants wait for a \textit{doCommit} request. When it arrives they \textit{commit}.

Explain how this protocol avoids delay to participants during their uncertain period due to the failure of the coordinator or other participants. Assume that communication does not fail.

4 (3 points) Three computers together provide a replicated service. The manufacturers claim that each computer has a mean time between failure of five days; a failure typically takes four hours to fix. What is the availability of the replicated service?
5 (2 points) The members of a group use *view-synchronous communication* to communicate with one another. Initially, there are four processes 0, 1, 2, 3. Process 0 sent a message $m$ in the view $(0, 1, 2, 3)$. Processes 0, 1, and 2 delivered the message $m$, but process 3 did not. Is this an acceptable behavior? Justify your answer.