**Question 1:**

Consider the quorum replication protocol shown in class.

a) Describe a scenario that demonstrates why lines 3&4 in the client side read protocol are required for correctness. In particular, which property might be violated without these lines?

b) Suppose the protocol runs with a general quorum system (rather than just a bi-quorum system, i.e., every read quorum is also a write quorum and vice versa). Propose an optimization that would enable skipping lines 3&4 sometimes without impacting the correctness of the protocol. The optimization should depend on the above assumption. No need to prove, but you should explain clearly why you think it works.

**Question 2:**

a) What is the purpose of Promise and Accepted messages sent with a NACK (rather than ACK) in the Paxos protocol?

b) Prove the termination property of Paxos under the assumptions that it is invoked with an $\Omega$ failure detector, there is at least a quorum of processes that never crash (never fail), and the network eventually delivers all messages sent between two processes that do not crash.

**Question 3:**

a) What would happen to Paxos' correctness if it was given a $\diamondsuit S$ failure detector and the presumed leader of a round is locally chosen by each process as some deterministic function of all unsuspected nodes (of the $\diamondsuit S$ failure detector)? Explain.

b) Suppose we run Mostefaoui&Raynal but change the way a round's coordinator is chosen to be the output of an $\Omega$ failure detector. Would the protocol run correctly? Explain.

c) Is it possible to use an $\Omega$ failure detector (instead of $\diamondsuit S$) in Mostefaoui&Raynal without changing the algorithm? If yes, describe how? If not, explain why?

**Submission instructions:**

You should solve this exercise alone – submissions are individual. Solutions must be submitted through the course web site – either printed or a high-resolution scan of handwriting. Solutions must be written in Hebrew unless you get an authorization from Prof. Friedman to submit in English.

Notice, each question has a brief solution. If your answer is lengthy, it could be a sign that it is wrong.

The submission date is Wednesday 14/12/2016 before midnight.

**Good luck!**