**Question 2 (10 points)** The Bully Algorithm solves the leader election problem in a synchronous system with process crashes and recoveries.

Suppose the Bully Algorithm is used in an asynchronous system where processes may crash and may recover. Before the algorithm is executed, the system administrator determines the timeouts $T$ and $T'$ based on observed message and processing latencies over a short period of time. The algorithm is configured to use these selected timeouts.

Describe an execution of the Bully algorithm (in this asynchronous system model with $N > 2$) that leads to more than one process declaring itself the leader.

**Question 3 (10 points)** Recall that in the proof of the FLP theorem, we first assumed that there is a protocol $\mathcal{P}$ that is totally correct in spite of one fault. We then used Lemmas 2 and 3 to develop a contradiction: we showed that it is possible to construct an infinite admissible run in which no process fails but no process ever decides.

Briefly describe one part of the proof (of either Lemma 2 or Lemma 3) that relied on the failure of one process.

**Question 4 (10 points)** Recall Lamport’s algorithm for the Byzantine Generals problem with oral messages.

1. What is the big-O notation message complexity of this algorithm (as a function of $N$ and $m$)?

2. Consider an execution of Lamport’s algorithm with $N = 7$ and $m = 2$ where all processes are correct (loyal). How many messages are sent in total? Give a number and show how you derived your answer.