Theory of Distributed Systems
Exercise Sheet 6
Due: Wednesday, 9th of June 2021, 12:00 noon

Exercise 1: Leader Election with Failures (8 Points)
Consider the leader election problem on a complete graph in the synchronous message passing model. That is, every node has a unique ID and at end of the algorithm, every node that did not crash has to output the ID of the leader node.
Show that if at most \( f \leq n - 2 \) processes fail during the protocol, at least \( f + 1 \) rounds are needed to solve leader election.

Exercise 2: k-Set Agreement with Failures (12 Points)
A generalization of consensus is the k-set agreement problem: Every node has some input value and at the end every node has to output a value such that the following validity properties are fulfilled:

1. There must not be more than \( k \) different output values.
2. Every node that did not fail must output a value which was input of some node.
Show that on a complete graph in the synchronous message passing model with at most \( f \) node failures, the k-set agreement problem is solvable in \( \lceil f/k \rceil + 1 \) rounds. Argue why that upper bound is tight.