Problem 1 Consider the early-stopping algorithm that we saw in class for TRB. Replace the line 9 statement:

“else if $k = f + 1$ or $|\text{faulty}(p,k)| < k$” with

“else if $k = f + 1$ or $|\text{faulty}(p,k)| = |\text{faulty}(p,k-1)|$”

In this protocol, a processes halts if it does not see any new failures in a round.

1. Prove this is a $t$-tolerant early stopping TRB protocol for crash failures.
2. Prove it is not a correct $t$-tolerant TRB protocol for send-omission failures.

Problem 2 Suppose that we have an algorithm that solves consensus in $f + 1$ rounds in a synchronous system and tolerates $f$ crash failures. Use that consensus algorithm to solve Terminating Reliable Broadcast for crash failures in $f + 2$ rounds in a synchronous system with $f$ crash failures. You have to present your algorithm and prove that it satisfies Termination, Agreement, Validity and Integrity.

Problem 3 The next question concerns Uniform TRB—a stronger version of TRB, where the Agreement requirement is replaced by:

**Uniform Agreement** If any process (whether correct or faulty) delivers a message $m$, then all correct processes eventually deliver $m$.

Consider the problem of solving Uniform TRB in a round-based system with general omission failures.

1. Assume that a majority of processes are correct, i.e. $n > 2t$. Describe a round-based algorithm that solves the above problem and prove it correct.
2. Prove that this problem cannot be solved if $n \leq 2t$. (Hint: partition the $n$ processes into two sets of size at most $t$, and consider several scenarios.)