Problem 1
Suppose that we want to build a synchronous system of \( n \) nodes that can achieve Byzantine agreement in the presence of \( f \) Byzantine failure and \( t \) crash failure.

1. What is the minimum number of nodes required to achieve Byzantine agreement? Explain your answer.

2. Assume \( f = 1 \) and \( t = 1 \). Explain why at least 3 rounds are necessary to achieve Byzantine agreement in this case.

Problem 2
State true or false with an explanation: If a sequentially consistent shared memory contains only 1 variable, then it is also a linearizable shared memory.

Problem 3
(Question 18.13 from the textbook-5th edition) In a gossip system, a front end has a timestamp (3,5,7) representing the data it has received from members of a group of three replica managers. The tree replica managers have vector timestamps (4,2,8), (4,5,6) and (4,5,8), respectively. Which replica managers could immediately satisfy a query from the front end, and what would the resultant timestamp of the front end be? Which could incorporate an update from the front end immediately?

Problem 4
Why Gossip-based system is not appropriate for updating replicas in near-real time? Provide an alternative approach.

Problem 5
In a replication system, the total number of servers is 4. 2 servers have an independent probability \( p = 0.3 \) of failing each, the 3rd server has \( p = 0.5 \) and the last one has \( p = 1 \). What is the availability of an object stored at each of these servers?