Principles of Distributed Computing
Exercise 2: Sample Solution

1. Leader Election in an “almost anonymous” Ring

   a) Yes, it is possible:

   **Algorithm 1** Leader Election (all but one nodes have the same ID)
   1. send IDs two hops around the ring
   2. if the same ID has been received twice AND the received ID differs from the own ID then
   3. I am the leader
   4. end if

2. Distributed Computation of the AND

   a) Because the size of the ring is not known to the nodes, the case where all nodes have a one as input and the case where all but one nodes have a one as input cannot be distinguished.

   b) All input values have to be sent all around the ring. In order to detect the returning of the own message, we add a hop counter to each message. If the message has made \( n \) hops, it has arrived where it started.

   c) The following algorithm calculates the AND in a synchronous, non-uniform ring:

   **Algorithm 2** AND in the Ring: asynchronous, non-uniform (\( n \) is the number of nodes)
   1. if input bit = 0 then
   2. send 0 to the neighbor in the ring
   3. end if;
   4. for \( i := 2 \) to \( n \) do
   5. if received a 0 and have not already sent a 0 then
   6. send 0 to the neighbor in the ring
   7. end if
   8. end for;
   9. if received at least one 0 then
   10. result := 0
   11. else
   12. result := 1
   13. end if;

   If the result is 1, no message is sent, otherwise there is exactly one message over each link. Thus, time and message complexity are both \( n \).