1. Suppose that Rana’s algorithm is adapted as follows: Only quiet processes that have been quiet from some logical time \(< t\) (instead of \(\leq t\)) onward can take part in a wave tagged with time stamp \(t\). Give an example of a finite computation for which termination would not be detected. (9 pts)

2. Show, using the technique to reduce garbage collection algorithms to termination detection algorithms, that indirect reference counting gives rise to Dijkstra-Scholten termination detection. (12 pts)

3. Run the Merlin-Segall algorithm on the following undirected weighted network, to compute all shortest paths toward process \(t\). Give a computation that takes four rounds before the correct sink tree has been computed. Give the complete set of messages for the first round, and (only) the outcomes for all subsequent rounds.

(12 pts)
4. Argue that in the Gallager-Humblet-Spira algorithm, any fragment at a level \( \ell \) always contains at least \( 2^\ell \) processes. (10 pts)

5. Apply the Itai-Rodeh ring size algorithm to an anonymous directed ring of size six. Give a computation in which all processes compute ring size four while not all processes select the same (random) id in this estimate round. (12 pts)

6. Suppose we adapt the Chandra-Toueg algorithm \( k \)-crash consensus for \( k < \frac{N}{2} \) as follows. If the coordinator \( p_c \) receives at least (instead of more than) \( k \) positive acknowledgments \( \text{ack} \), then \( p_c \) decides for its value. Give an example, with \( N = 3 \) and \( k = 1 \), to show that this could lead to inconsistent decisions. (12 pts)

7. Let \( N = 5 \) and \( k = 1 \), and let the general \( g \) be Byzantine. Suppose that in pulse 1, \( g \) sends the value 1 to two lieutenants, and the value 0 to the other two lieutenants. Give a computation of \( \text{Broadcast}_g(5, 1) \) (in full detail, and including a definition of the \textit{majority} function) such that all lieutenants decide for 0. (12 pts)

8. Give an example of a computation on Dijkstra’s token ring with \( N = K = 4 \) that takes 13 events to reach a correct configuration. (12 pts)