1. *15 marks*

   (a) Define the specification of the i) Reliable Broadcast, ii) FIFO Broadcast and iii) Causal Broadcast.

   (b) Describe three algorithms that implement respectively the three different types of Broadcast mentioned above in an asynchronous system, with process crash failures.

   (c) What is the time and communication complexity of your FIFO Broadcast Algorithm? Prove it.

2. *15 marks*

   (a) Use the Reliable Broadcast algorithm that you have described in question 1 to elect a leader (coordinator) on your network.

   (b) What is the time and communication complexity of your algorithm?

3. *15 marks*

   (a) Describe a non-blocking algorithm that uses the leader that you have established from the previous question that solves the consensus problem on a system with process crashes.

   (b) Can you extend this algorithm to an algorithm that works also for systems with link failures? If yes describe the extension, if not describe a proof.

4. *15 marks*

   Construct a replica management scheme from protocols that have been provided by the answers of the previous questions.