1. *30 marks*

   (a) What are the properties that a reliable Broadcast (multicast) must satisfy? Explain the properties after stating them.

   (b) Is it possible to implement a reliable and totally-ordered multicast in asynchronous distributed systems in general (i.e. without group-membership services)?

   (c) Does the Ensemble library support a reliable and totally-ordered multicast? If yes, how can the library support such a multicast? Does this constradict the previous question? Explain your answer.

2. *15 marks*

   (a) Explain why a multi-threaded server might not qualify as a state machine.

   (b) Describe in detail the 3 basic approaches for replication.

   (c) How can one use Gifford's quorum consensus to tune responce times of requests on a set of replicas? If we have a trust function that describes the trust that we have on different severs, how can we use Gifford's quorum consensus on top of that to tune trust of responses?

3. *15 marks*

   Describe an algorithm that solves the problem of mutual exclusion on a general network. Provide a correctness proof and also a complexity analysis of your algorithm.