OLLSCOIL NA hÉIREANN
THE NATIONAL UNIVERSITY OF IRELAND, CORK

COLÁISTE NA hOLLSCOILE, CORCAIGH
UNIVERSITY COLLEGE, CORK

Summer Examinations 2013

CS4616: Distributed Systems

Professor Barry O'Sullivan
Professor Michel Schellekens
Professor Ian Gent (Extern)

Answer all Questions

One and a half hour

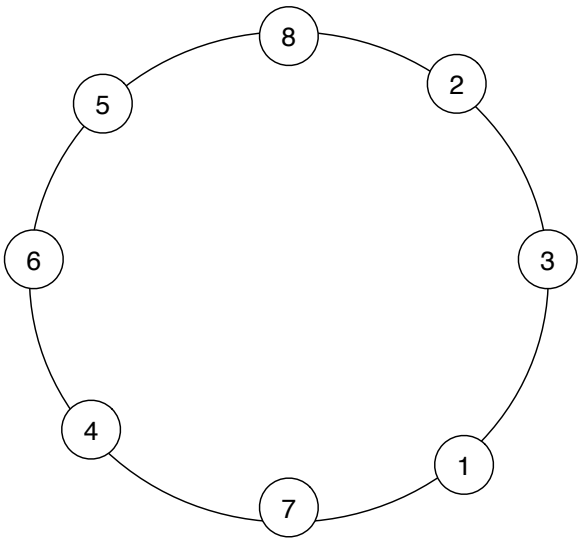
Question 1 [20 marks]

a) [5 marks]The LCR algorithm elects a leader in a uni-directional ring. Give the pseudo code for the transition function for this algorithm, $trans_i$ (where i is a process in the ring).

b) [2 marks] Give the time complexity for HR (no proof is needed).

c) [3 marks] Give the (worst-case) communication complexity for HR (no proof is needed).

d) [10 marks] Hirschberg and Sinclair's HS algorithm elects a leader in an efficient way by selecting the process with maximum UID, allowing bi-directional communication in a ring network. For a ring shaped network, as displayed below, compute the number of messages transmitted during the first phase and during the second phase of the HS algorithm. Display the local leaders on a drawing, for each stage, as well as arrows for the messages passed during the execution of each phase.

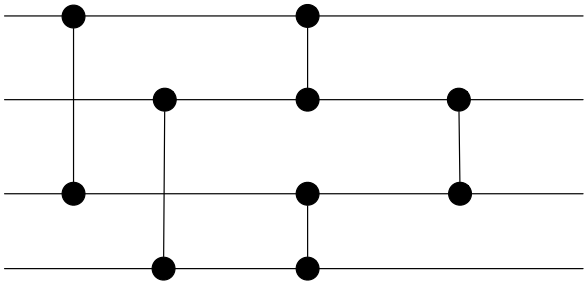


Question 2 [20 marks]

a) [2 marks] To verify that a sorting network is correct, using the zero-one principle, you can leave out the already sorted binary sequences in your test. Explain why.

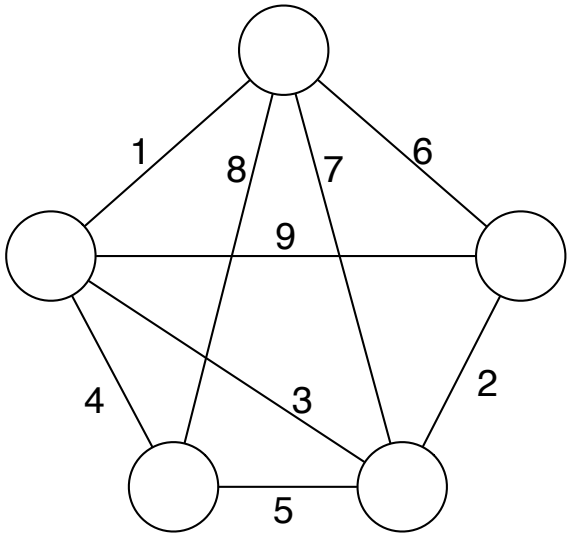
b) [8 marks] Use the zero-one principle to verify that the sorting network given below is correct. For this exercise, you only need to carry out the test for the following four sequences: 0010, 0100, 0101 and 0110. Make sure you indicate the intermediate steps to display how the sorting network acts with each comparator.

c) [10 marks] Show that any n-input sorting network must contain at least one comparator between the ith and the $(i+1)$th lines for all $i \in \{1, ..., n-1\}$.



Question 3 [20 marks]

The SynchGHS algorithm constructs a minimum spanning tree for a given graph with distinct weights at the edges. Show how SynchGHS constructs a minimum spanning tree for the graph given below. Display the end result created after each round of the algorithm.



Question 4 [20 marks]

a) [2 marks] What is the outcome of the random attack algorithm when one of the inputs is zero?

b) [3 marks] List the triples defining the good communication pattern for the graph displayed on the next page.

c) [10 marks] Consider the random attack algorithm. For a given adversary B, we know that: $Prob^B$[some process decides 0 and some process decides 1]$\leq \frac{1}{r}$ where r is the number of rounds. Consider the good communication pattern γ depicted by the graph on the next page. Indicate the information levels for the graph.

d) [5 marks] Compute the exact value of $Prob^B$[some process decides 0 and some process

decides 1] for the communication pattern given in c) (displayed below). Give sufficient detail in your argument to show how you arrived at the answer, using the information levels you derived in c). Assume, as typical in this analysis, that the three inputs for the algorithm are 1.

Communication pattern