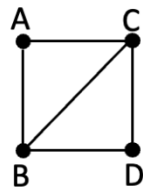


Distributed System: Midterm Exam

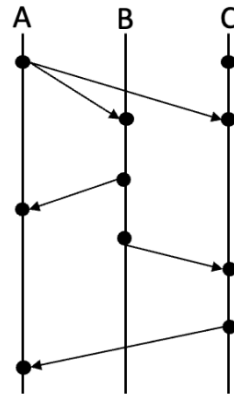
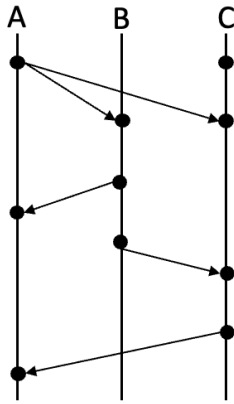
Name: _____

1. [25 points] Using DCDL to write an extended *squash* program (in class note 3, pp. 19-20) that replaces “ab” by “ac”. E.g., “abdbbabc” is replaced by “acdbbacc”. Use three processes, *input*, *output*, and *squash*. However, the rate from squash to output should be the same as the one from input to squash. That is, the output rate should be the same as the input rate without any gap.

2. [25 points] Consider the Chandy and Lamport solution (pp. 83-85) for global snapshot applied to the given network below. Suppose A is the initiator. Other than the initiator, each node in the network has a "parent" (the place where current node receives the command for the first time).
- Provide all possible parent-child configurations, i.e., all possible spanning trees rooted at A.
 - Suppose each link is symmetric in terms of delay in two directions. Also, link delays are drawn from $\{1, 2, 3, 4, 5, 6, 7, 8, 9\}$. Provide two link delay assignments that correspond to two different spanning trees.



3. [25 points] Given a distributed system with three communicating processes: A, B, and C. The first communication from A is a broadcast (can be treated at multiple unicast at the same time). The incremental value $d=1$ and initialization value $int_i=0$.
- Find out vector clocks for A, B, and C on the given graph.
 - Determine matrix clocks (page 91) for A, B, and C on the same graph.
 - Interpret each element of 3×3 matrix associated with A after the last event of A.



4. [25 points] Apply wound-wait and wait-die schemes (pp. 148-151) to the example below. You are required to show the status of each process on two resource queues, A and B, over the time. For A, B, it means the process first secure A and then B. Process cannot start before securing both. When a process is killed or wounded, it must restart all over again. Show all the steps whenever there is status change.

| ID | 1 st request time, | priority, | length, | retry interval, | resource (in order) |
|----|-------------------------------|-----------|---------|-----------------|---------------------|
| P1 | 1 | 2 | 2 | 3 | A |
| P2 | 2 | 1 | 3 | 2 | A, B |
| P3 | 3 | 3 | 1 | 1 | B, A |

5. Bonus: [10 points] In token-ring-based algorithm (p. 113) for mutual exclusion, the ring structure is a logical one.
- How can we map this logical ring to a physical network? Demonstrate your approach on the given network.
 - After a mapping from a logical ring to a physical ring, a physical node may appear more than once in the logical ring. How will you distinguish the same physical node that appear at different locations in a logical ring? Illustrate your solution on the graph.

