BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, PILANI (RAJ.)
First Semester 2022-23
CS G623
Advanced Operating Systems
MIDSEM EXAMINATION [Closed Book]

Date: 1st November 2022 Weightage: 25 % Max. Marks: 50 Duration: Total 90 minutes

Instructions: Question paper consists of two parts – A and B, of 25 marks each. Part A contains short-answer type questions while Part B contains descriptive-answer type questions. You need to **answer Part A on this sheet itself**. You may use the main answer sheet's last page for its rough work. There is no individual time limit for each part. You can **collect Part B *after submitting* Part A**.

PART A [25 Marks]

1. State whether the following are True or False and provide a one sentence justification for your answer: [2*5 = 10]
   a) Causal ordering implies total ordering and FIFO ordering with logical clocks.

   b) The Chandy-Lamport global state recording algorithm works correctly for non-FIFO channels.

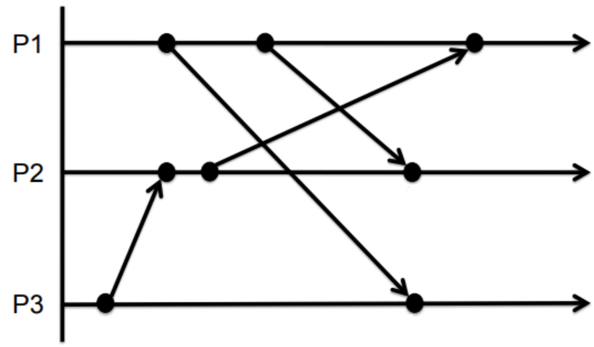
   c) In a system with N processes, the Chandy-Lamport algorithm will always show that at least (N-1) channels are empty.

   d) It is possible to solve Byzantine Generals problem in an asynchronous system where all the generals (processes) are loyal (correct) but the messages may be dropped.

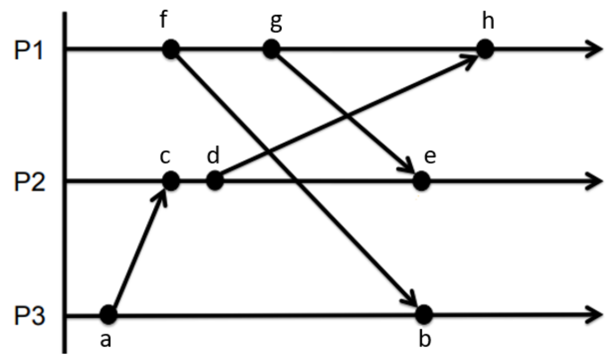
   e) The packing and unpacking of parameters in RPCs is handled by the binding server.

2. Lamport's clocks do not guarantee that if $L(e1) < L(e2)$ then $e1 \rightarrow e2$, where $\rightarrow$ indicates the "happened-before" relation between two events and $L(e)$ denotes the timestamp of event e, at whatever process it occurred. Show an example that demonstrates that even if $L(e1) < L(e2)$, it is not true that $e1 \rightarrow e2$, using 3 processes. Clearly mark which two events demonstrate it. [3]

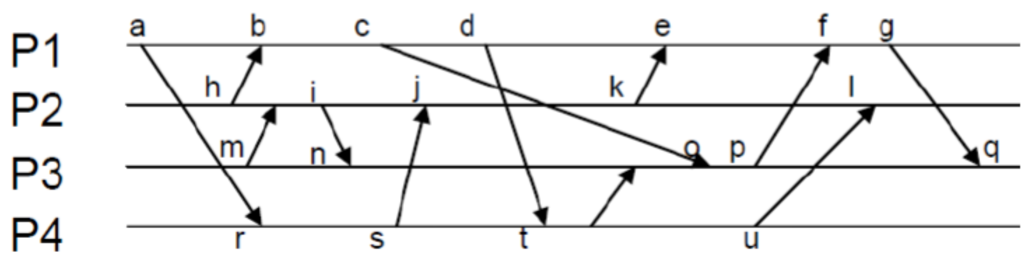
3. Consider the following diagram on the right for processes P1, P2, and P3 on the right. Illustrate (on the diagram itself): one inconsistent cut, one strongly consistent cut, and one consistent cut which is not strongly consistent. [3]



4. Using the vector logical clocks, list all possible pairs of concurrent events that appear in the timeline on the right. Denote a pair of concurrent events using ‖ symbol. [3]



5. Consider a scenario of four processes P1, P2, P3 and P4 which run the events *a, b, c, d, e, f, g, h, i, j, k, l, m, n, o, p, q, r, s, t and u* to send and receive messages. List the vector clock timestamps for all these events. Assume all the initial clock values as 0 and the first event is ‘a’. [6]



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PART B [25 Marks]

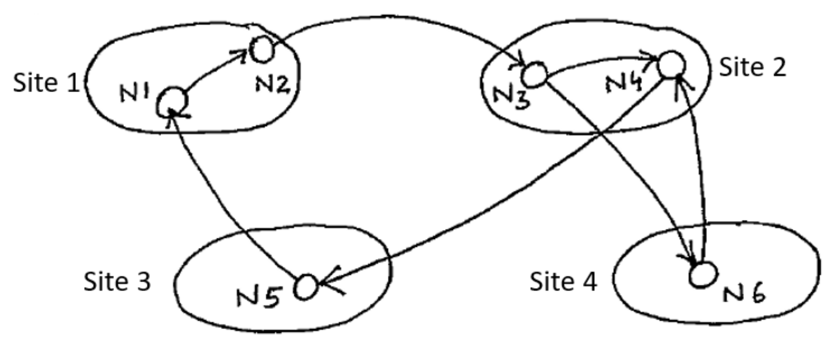
Instructions for Part B:

1. Answer Part B on the main answer sheet.
2. Answer each question on a fresh page.
3. Answer all parts of the same question together.

1. Consider the Ricart-Agrawala algorithm for distributed mutual exclusion among the processes P1, P2, P3 and P4, which require access to the critical section. Assume that P1 is currently in the Critical Section (CS). Now, there are requests from P4, P3 and P2 (in that order) to enter the CS. Assume that the request messages from P4, P3, P2 arrive at other peers in the order of requests. [4+4+2=10]
   (a) Depict the working of the Ricart-Agrawala algorithm for the above described scenario. Show all entries at each processor.
   (b) P1 now exits the critical section and informs all the relevant nodes that the critical section has been released. Show all entries at each processor at this stage.
   (c) Discuss the message complexity of the Ricart-Agrawala algorithm comprising of N sites.

2. In a distributed system with non-FIFO communication channel, the messages sent in one order may arrive at the receiver in a different order. Will the Chandy-Lamport Global State Recording algorithm work in this environment? Give a clear YES or NO as an answer. If your answer is YES, give a clear justification in support of it. If your answer is NO, suggest a modification to the algorithm to accommodate the given condition. [5]

3. For the following Wait-for graph, list out the relevant messages and detect deadlock, if exists, using the Diffusion Computation Chandy-Mishra-Haas Algorithm. [5]



4. Consider Byzantine Agreement in a scenario with four nodes P, Q, R and S, where node S is the source and is byzantine. The byzantine behavior of S is such that it broadcasts the value 1 to (any) two nodes, but the value 0 to the third node. Show the working of the Byzantine Agreement protocol in this scenario and demonstrate whether the conditions of agreement, validity and termination are met. [5]