Ref. No.: EX/IT/T/323/2019

B.E. INFORMATION TECHNOLOGY 3RD YEAR 2ND SEMESTER EXAMINATION-2019

Subject- Distributed Systems: Algorithms

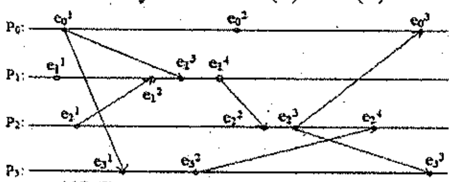
Time: 3 Hours **Full Marks: 100**

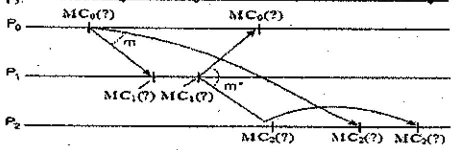
(Note: Answer must be brief and to the point and answers of all parts of a question should be written together)

CO1 (20)

Q.1 Answer any *one* from (a) and (b):

a.





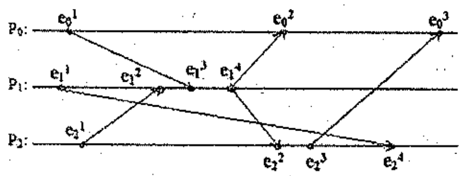
i) Update the clock-value after occurring each event at the processes P_0 to P_3 (in the figure) using rules of Vector Clock.

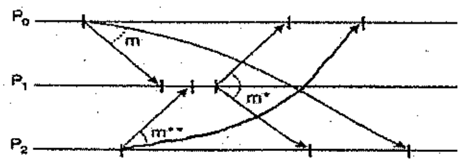
ii) How can the causality of events be captured by Vector Clock & Matrix Clock?

iii) Establish the rules (and assumptions, if required) for causally-ordered multicasting of messages by Matrix Clock. Hence, update the clock value for each $MC_i(?)$, i= 0, 1 and 2 (in the figure).

8+(2+3)+7

b.





i) Update the clock-value after each event occurred at the processes, P_0 to P_2 (in the figure) using rules of Matrix Clock.

ii) Why is it not always a good idea to aim at implementing the highest degree of transparency possible?

iii) Check the causal ordering of messages at the processes P_0, P_1 and P_2 (in the figure) using Vector Clock.

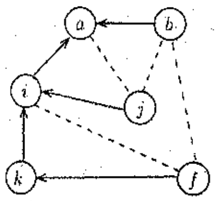
iv) "If a system supports replication transparency then it generally supports location transparency" - Explain with suitable examples.

8+3+6+3

CO2 (15)

Q.2 Answer (a) and any *one* from (b) and (c):

a.



Apply suitable message passing algorithm (with timing diagram) to construct a spanning tree from the given graph (in the figure) where nodes represent distributed processes. Also compute number messages exchanged in constructing the spanning tree.

8

b. i) How are time complexity and message complexity measured in asynchronous and synchronous distributed model?

ii) Describe transitions in asynchronous and synchronous distributed systems.

3+4

c. i) Distinguish between asynchronous and synchronous distributed systems.

ii) Describe safety property and liveness property w.r.t. distributed message passing systems.

3+4

CO3 (15)

Q.3 Answer any *one* from (a) and (b):

a. i) Write the pseudo code with suitable example of Bully Algorithm for electing a coordinator.

ii) A distributed system has n number of processes having ids *0* to *n-1* running in *n* respective machines. The i^{th} and j^{th} processes i.e., P_i and P_j respectively (where i < j) are the initiators of the election algorithm. How many messages will be transmitted to elect a leader using Bully Algorithm and Ring Algorithms?

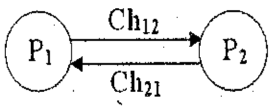
8+7

b. i) Write the pseudo code with suitable example of Ring Algorithm for electing a coordinator.

ii) How many average number of messages will be transmitted in electing a coordinator among *n* number of processes (denoted by P_0 to P_{n-1}, including present coordinator which is currently down) for Bully and Ring algorithms?

8+7

P.T.O.

CO4 (30)	Q.4 Answer any *two* from (a), (b) and (c): a. i)  State marker sending and receiving rules for taking global snapshot of a distributed system. Hence, apply these rules on the system as given in the figure to determine global state. Assume a distributed monetary transaction is running on the system consisting of two distributed processes P_1 and P_2 connected by two channels Ch_{12} and Ch_{21} respectively (in the figure). ii) What is knot? Explain: p-out-of-q model is most generalized form of other standard models. iii)Prove that: $S = (s_1, s_2, s_3, \ldots\ldots\ldots s_n)$ is a consistent global state where state s_i is received from the process p_i iff $V(s_i)[i] \geq V(s_j)[i]$ for $i, j = 1, 2, 3, \ldots\ldots\ldots, n$. (3+4)+(2+3)+3 b. i) Write either advantage(s) or disadvantage(s) of path pushing, edge-chasing and diffusion-computation class of algorithms. ii) Prove that: presence of a cycle in WFG does not mean a deadlock. iii)Differentiate between Run and Linearization with suitable examples. iv)How a process in distributed system may be in four states in Mitchell and Merritt's Algorithm? v) What action will be taken by a process when more than one marker message is received, sent by different monitors/initiators? 3+3+(2+2)+3+2 c. i) In a distributed system, there are *m* number of sites and each site consists of *n* number of processes. How many maximum and minimum number messages can be exchanged using Chandy-Misra-Haas algorithm to detect a GWFG? ii) Explain with suitable example(s): Any subset of the global history cannot be a cut. iii)When the Chandy-Lamport 'snapshot' algorithm is terminated for any other and monitor processes? iv)Prove that: presence of a knot in WFG does not necessarily mean a deadlock. v) When a distribution computation is assumed to be terminated? (2+2)+3+3+3+2
CO5 (20)	Q.6 Answer any *one* from (a) and (b): a. i) Write the minimum steps of Suzuki-Kasami Broadcast algorithm for synchronous delay as zero. ii) Prove that: Lamport's mutual exclusion algorithm is fair. iii)State the intersection and minimality properties of quorum based mutual exclusion algorithm. iv)How are response time, synchronous delay and system throughput measured in distributed mutual exclusion? 6+4+4+6 b. i) How are two design issues of Suzuki Kasami's Broadcast algorithm addressed? What are probable drawbacks of the algorithm? ii) Prove that: Maekawa's algorithm achieves mutual exclusion. iii)Compare the message complexities of Lamport's, Ricart-Agrawala's, Maekawa's and Suzuki Kasami's mutual exclusion algorithms. iv)State safety property, liveness property and fairness property of distributed mutual exclusion. (4+2)+4+4+6

-:Course Outcomes:-

CO1: Express Distributed Systems software & hardware infrastructure issues, design goals, challenges and discuss causality and general framework of logical clocks in distributed systems.

CO2: Illustrate algorithms for distributed message passing system and solve related problems.

CO3: Sketch different leader election algorithms and their analysis in uniform/non-uniform, asynchronous/synchronous rings.

CO4: Describe and analyze the concept of Global States and snapshot Recording Algorithms and extend them to solve distributed deadlock detection, termination detection.

CO5: Analyze, compare and distinguish different distributed mutual exclusion algorithms and Wave Traversal Algorithms and solve problems.