Ref. No.: Ex/IT/PC/B/T/413/2025

JADAVPUR UNIVERSITY
DEPARTMENT OF INFORMATION TECHNOLOGY
B.E. INFORMATION TECHNOLOGY, FOURTH YEAR
FIRST SEMESTER EXAM 2025
SUBJECT: DISTRIBUTED COMPUTING

Full Marks :100 **Time : 3Hrs**

CO1 : (20) **Answer any one question** **1 X 20 =20**

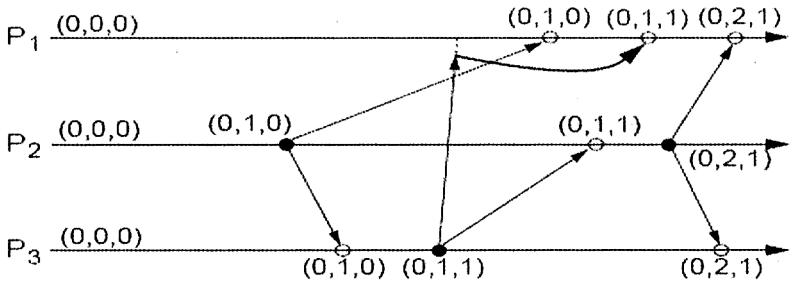
i)

a) Mention the types of transparencies present in distributed systems.

b) Explain how logical clocks can be used to mark a unique time-stamp for each event across different nodes in a distributed system.

c) A distributed system is charged with the responsibility of counting number of tokens rotating in a ring. The system has a fixed number of processes. Informally describe what each process will do, what inter process messages will be exchanged? Is it possible to get a correct result? If not why?

d) Describe all the events that are happening in the given diagram below. How this type of clock has overcome the limitations of Lamport's Clock.



4+5+5+6=20

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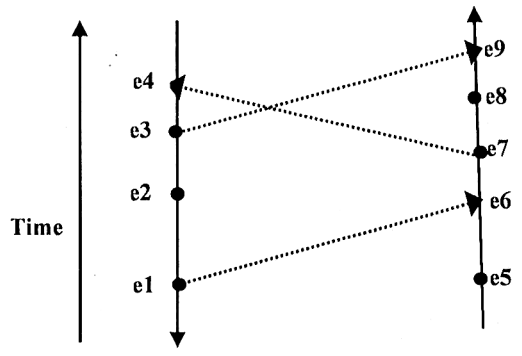
ii)



a) Using the above space time diagram list all pairs of concurrent events according to the happened before relation. Add a message sending event to the space time diagram that is concurrent to events e5, e6 and e7. Now add a non message sending event that is concurrent to events e1, e2 and e3. Explain the mechanism how causal communication has been enforced in vector clocks.

b) What is the difference between synchronous and asynchronous DS? Describe an application in which the lack of synchronization among physical clocks can lead to a security breach.

(4+2+2+4)+ (4+4) =20

CO2 : (20) **Answer any two questions** **2X 10 =20**

i)

a)What is the role of channels in a global snapshot algorithm?
b) What are the issues to be addressed before recording a global state?
c) What do you mean by frontier of a CUT? Give an example.
d) During an election, if the highest-ID process fails before declaring itself the leader, how does the algorithm proceed to ensure a new leader is elected? **2+3+2+3 =10**

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ii)

a) What is a consistent cut in the context of distributed systems, and why is it important for ensuring system consistency?
b) Give Marker receiving rule and consider a distributed system with three processes P1, P2, and P3,connected as follows:

P1 -> P2
P2 -> P3
P3 -> P1

Apply Chandy Lamport's Snapshot Alogorithm to ensure that a consistent snapshot of the global state got captured. Clearly mention each step of the process. **3+7 =10**

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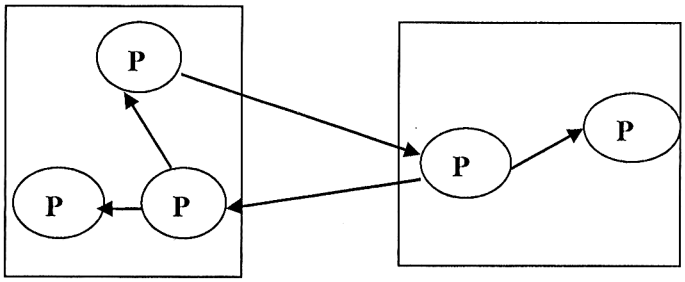
iii)

a) In a system with 10 processes, if the process with ID 2 initiates the election, how many messages are exchanged in the worst case before the new leader is elected?
b) What assumptions does the Chandy-Lamport algorithm make about the system?
c) Describe the Ring Algorithm for leader election. How does it ensure fairness?

3+3+4 =10

CO3 : (20) **Answer any five questions** **5X4=20**

i) Mention the performance metrics of distributed Mutual exclusion algorithms.
ii) Prove that Lamport's Mutual exclusion algorithm obeys fairness property.
iii) Describe Lamport's Algorithm for distributed mutual exclusion.
iv) Illustrate Lamport's Algorithm for 4 nodes with all having degree 4.
v) Describe the limitations of Lamport's Algorithm and give the optimizations made to enhance it.
vi) Give the correctness of Suzuki Kasami's Broadcast Algorithm .

CO4 : (10)	**Answer any one question** **1X10 =10**
	i) What is a knot? Write a pseudo code for Probe-based distributed algorithm for deadlock detection in a distributed system. What are the main advantages of this algorithm over a WFG based distributed algorithm ? **2+5+3 =10** ..... **ii)** Complete the diagram given below by labeling the probes correctly. Illustrate the steps of CMH algorithm using the given figure. Prove that for a system having only one unit of each resource type the presence of a cycle in a resource allocation graph is both a necessary and a sufficient condition for the existence of deadlock. **4+4+2 =10** 
CO5 : (15)	**Answer any five questions** **5 X 3 = 15** Q. i) What are the primary design principles of the Google File System, and how do they address the unique needs of Google's large-scale data processing? ii) How does GFS balance scalability with fault tolerance, and what architectural decisions support this balance? iii) What mechanisms are implemented in GFS to handle hardware failures, and how do they minimize system downtime? iv) Where and how does the Master store metadata in the Google File System? v) How does GFS implement replication and consistency, and what trade-offs are made to ensure data availability and durability? vi) What role does chunk size play in GFS, and how does its configuration impact performance and resource utilization? vii) How is a write operation performed in Google file system?
CO6 : (15)	**Answer All questions** **15** Q. **i)** Assume the system has four sites. The user enters transaction T into the system at Site 0. There are three tables in the system defined as: Person (SSN, Name, Profession, Sal) stored at Site 1, Car (Name, Make, Year, SSN) stored at Site 2 and Home (Address, No-of-rooms, SSN) stored at Site 3.For this distributed system, we want to print car and home address information for every person who makes more than $100,000. Describe the Global as well as Local execution plans. Draw a neat diagram to represent the scenario. You must mention the messages that needs to be communicated in the network to complete the transaction. **3+3+3 =9** **ii)** Mention the two major failures that can occur during 2PC for a transaction. Explain how 2PC ensures atomicity despite the failure. Mention the type of failure that 2PC cannot handle. **2+2+2=6**