General Instruction: Question Paper contains total 11 questions. It should be printed on both the sides. Do not write anything in the question paper. Clearly mention assumptions (if required) taken for answering the questions. Try to write precise and to the point answers.
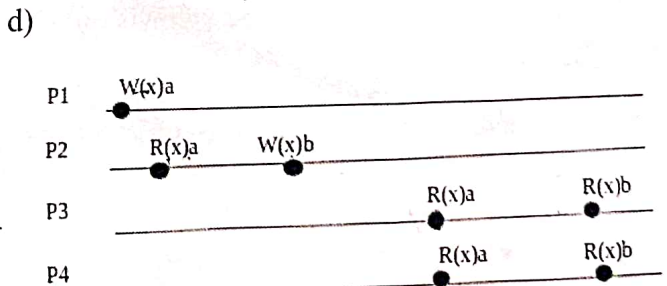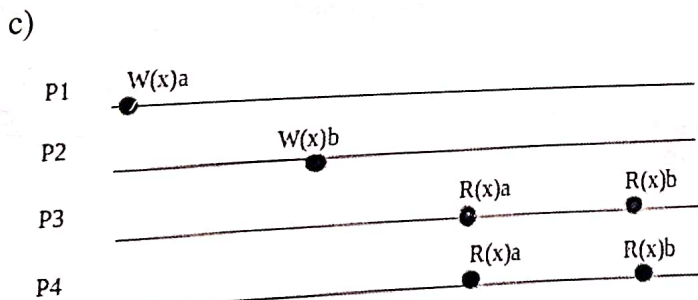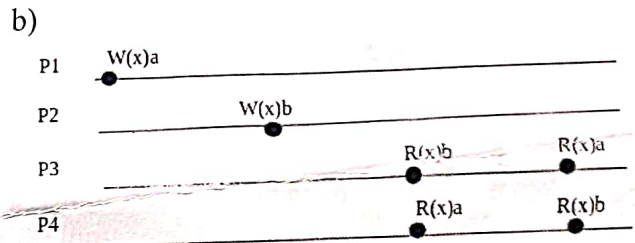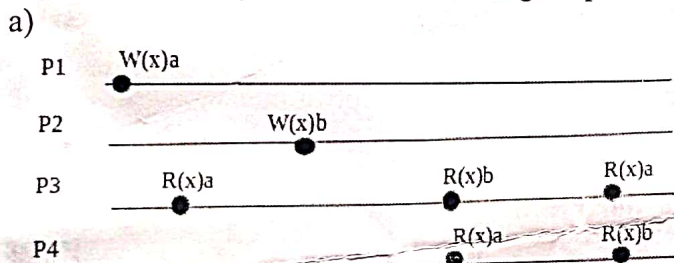
Q.1) What is the advantage if your server-side processing uses threads instead of a single process?
(5 Marks)

Q.2) Why would you design a system as a distributed system? List some advantages of distributed systems.
(5 Marks)

Q.3) A process in a distributed system runs on one node and accesses data from another node. After some time, for load balancing purposes, this process relocates to a different node. What kind of transparencies should be provided for this process in a distributed system?
(6 Marks)

Q.4) Explain, with an example, the reasoning behind not using the #pragma omp critical for controlling the race condition.
(8 Marks)

Q.5) Explain the different design issues in the content distribution of replica management. Further compare push and pull protocol corresponding to these issues.
(4 + 4 Marks)

Q.6) What are the different Election-algorithms for selecting a coordinator process. Explain the working of Bully algorithm with an example.
(3 + 5 Marks)

Q.7) What is the little and big-endian data format. How does it affect the distributed systems. Explain with the suitable example.
(3 + 5 Marks)

Q.8) What are the differences between Decentralized and Distributed algorithm for achieving the mutual exclusion. Explain the stepwise implementation of Distributed algorithm for achieving the mutual exclusion.
(4 + 6 Marks)

Q.9) In a distributed system, four processes (P1, P2, P3 and P4) are running on different replicas of a server. All these four processes are working on the same data item x. Any write by process i to a data item x is denoted by $Wi(x)c$ where c is the content written on the data item x. $Ri(x)c$ denotes the read operation of the data item x (having value c) by process i. Now given the following dependencies, fill the below diagram for the correct sequence of events in causally consistent replicas.
Dependencies: $W2(x)b$ is dependent on $R2(x)a$. $W3(x)c$ is dependent on $R3(x)b$. $W1(x)d$ is dependent on $R1(x)c$.
(10 Marks)

P1: W1(x)a _____

P2: _____

P3: _____

P4: _____

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Q.10) Will the following code segment parallelly compute the correct value of pi (π)? Explain your answer properly.
(10 Marks)

```
double area, pi, x;
int i, n;
...
area = 0.0;
#pragma omp parallel for private(x)
for (i = 0; i < n; i++)
{
x = (i+0.5)/n;
area += 4.0/(1.0 + x*x);
}
pi = area / n;
```

Q.11) In a distributed system, four processes (P1, P2, P3 and P4) are running on different replicas of a server. All these four processes are working on the same data item x. Any write by process i to a data item x is denoted by $W(x)c$ where c is the content written on the data item x. $R(x)c$ denotes the read operation of the data item x (having value c). Below four different orderings of read and write operation is given. Determine, whether the ordering is following any consistency model, if yes then which consistency model it is following. Explain with suitable reasoning. **(4 * 3 Marks)**

a)

b)

c)

d)

--------------------End of the Question Paper--------------------