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Assignment - 4

Q1 A race condition occurs when Two people change the same shared resource at a time and the final result becomes incorrect due to Timing.

- example :- (Real life) → Two family members withdraw money from the same bank account at the same time. Both see balance ₹ 5000 and withdraw ₹ 3000 each. Expected remaining ₹ -1000 (invalid but system may show ₹ 2000 due to overwritten update.
- Mutual Exclusion fix :- Allow only one person at a Time to update the bank balance (like using a lock / Token).

Q2 peterson v/s Semaphores

features	Peterson's solution	Semaphores
complexity	works only for 2 processes harder on modern CPU	Simple API, work for multiple processes
Hardware Dependency	Need strict memory ordering, not reliable on multicore without barriers.	Uses CPU atomic instructions

Q3 producer - consumer :- Monitors provide mutual exclusion and condition variables, so threads sleep instead of busy waiting, improving performance on multi core systems.

Q4 Starvation :- if readers Keep coming continuously, a waiting writer may never get access or vice - versa.

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prevention Method :- Use fair Scheduling (FIFO queue) so requests are served in order and no group is starved.

5Q processes must request all resources at once before starting which leads to low resource utilization and more waiting time, reducing system efficiency

6Q a) Distributed Scheduling challenges load balancing Algo challenges :-
1) sudden high Traffic During flash sales.
2) uneven load across servers in diff Regions.
3) Network delay b/w continents
4) Keep data consistent across all servers.

Algorithm suggestion :-

→ Dynamic load balancing using consistent Hashing + least connection Algorithm.
→ Request are sent to the server with the fewest active connection.
→ Helps balance Traffic in Real Time.

b) fault Tolerance strategy (with RTO & RPO)
Strategy :-
→ Use Geo - Redundant Data centers with Active - Active Replication.
- Data is stored in Multiple Region.
- if one Region fails, another instantly takes over.

RTO : few seconds - Services switches automatically.
RPO : zero or near zero - no data loss because Data is continuosly Replicated.

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7Q a) Given :

- local access = 5ms
- Remote access = 25ms
- probability (Remote) = 0.3 →
  probability (Local) = 0.7

expected Time = $(0.7 \times 5) + (0.3 \times 25)$
$= 3.5 + 7.5 = 11ms$.

b) Caching strategy
→ use : client - size caching Recently accessed files Stored locally.

Justification :

- Most files are accessed Repeatly
- Keeping copies locally Reduces Remote access (25ms → 5ms)
- Greatly improves speed and Reduces Network load.

8Q Distributed Deadlock Detection stimulate on ! there sites S_1, S_2, S_3 have the following wait for graph fragments.

S_1 : $P_1 \rightarrow P_2$, $P_3 \rightarrow P_4$
S_2 : $P_2 \rightarrow P_5$, $P_5 \rightarrow P_6$
S_3 : $P_6 \rightarrow P_1$

a) combined global - wait - for graph
$P_1 \rightarrow P_2 \rightarrow P_5 \rightarrow P_6 \rightarrow$ and $P_3 \rightarrow P_4$

b) Since there is a cycle among P_1 P_2, P_5, P_6 a deadlock exist.

c) Suitable Distributed Detection Algorithm
Chandy - Missa - Haas algorithm - detect cycles in a

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Distributed wait - for - graph using prose message .

Q9 a) optimal min :-
Take full checkpoints at the start , followed by incremental checkpoints every 2 seconds

b) This ensure that at any Time Recovery is possible within 1 seconds (meeting RPO) while minimizing overhead since incremental check points are quickly less Resource - Intensive than full ones -