Assignment-4 _/_/_

Ans1 A race condition occurs when the outcome depends on the sequence or timing of uncontrollable events. Consider a simple banking scenario: two people attempt to withdraw money from the same joint account at the same time. If both check the balance and withdraw simultaneously without proper coordination, the final account balance might be incorrect, leading to an overdraft. Mutual exclusion addresses this by allowing only one withdrawal operation to take place at a time, ensuring accurate and consistent results

Ans 2. Peterson's solution is a software only algorithm for two process mutual exclusion, requiring no hardware support, but is limited to two processes and relies on strict atomicity of reads and write. Semaphores are synchronization primitives requiring atomic operations, often supported by dedicated hardware instructions. Semaphores scale more easily for multiple processes but depend on hardware atomicity, whereas Peterson's is simpler for two processes but not generalized or hardware accelerated.

Ans3 Monitors in producer - consumer

Monitors provide built in data encapsulation and synchronization, reducing the risk of concurrency errors. In a multi-core system, monitors can take advantage of object-oriented encapsulation, helping multiple threads interact with shared resources neatly without manual signaling and management.

Ans 4 Reader- Writer Starvation and Prevention

Starvation happens when writers repeatedly wait because new readers keep arriving, causing indefinite delay for writers. A common prevention method is to use writer- priority: once a writer arrives, further reader entries are blocked until all waiting writers complete, ensuring that writers are eventually served and not starved.

Ans 5 Drawbacks of Elimination Hold and Wait.

Elimination Hold and wait requires process to request all resources at once. This reduces flexibility often leading to under-utilization of resources. Processes may reserve resources they donot use immediately, potentially increasing system waiting times and decreasing overall efficiency. This is a practical drawback for multitasking and dynamic resource allocation in OS.

Ans 6 Distributed deadlock detection simulation

(a) Global wait- for graph: Combine the edges from fragments

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S1: P1 → P2, P3 → P4
S2: P2 → P5, P5 → P6
S3: P6 → P1

The graph has: P1 → P2 → P5 → P6 → P1
and P3 → P4

(b) Deadlock exists?: Yes, there's a cycle among P1, P2, P5 and P6. these processes are deadlocked.

(c) Algorithm: The Chandy-Misra-Haas Algorithm is a distributed approach suitable for deadlock detection in distributed systems.

Ans 7 Distributed file system Performance

(a) Expected file access time:

$E = (1 - P_{remote}) \times T_{local} + P_{remote} \times T_{remote}$

Where, $P_{remote} = 0.3$, $T_{local} = 5$ ms,

$T_{remote} = 25$ ms.

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

(b) Caching strategy – Use client-side caching with write-back policy. This reduces remote accesses by keeping frequently read files local and improves access time for repeated reads.

8. Checkpointing in concurrent systems

(a) Mix over 10 seconds - To keep recovery point objective (RPO) ≤ 1s, checkpoint atleast every second. Use one full checkpoint (200 ms) and nine incremental checkpoints (9 × 50ms = 450 ms). Total overhead: 650 ms per 10 seconds

(b) Reasoning - The full checkpoint captures system state completely; incremental checkpoints minimize further overhead while maintaining the RPO requirement.

9. Case Study - Global E-commerce Platform.

(a) Scheduling Challenges - Handling unpredictable surges in traffic during flash sales requires dynamic load balancing. Use Algorithm like dynamic Least connection or dynamic Round Robin for effective distribution.

(b) Fault Tolerance - Multi-region active-active deployment with automated failover and geo-redundancy ensures the services stay up. Combining frequent replication (to meet low RPO) and quick failover automation (to meet low RTO) provides robust availability across regions