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2301010433

Operating System

Assignment - 4

Part - A

1) Race condition with real world example and mutual exclusion.

Race condition: occurs when multiple entities ~~ace~~ assess shared resources simultaneously, causing inconsistent results.

Example (non-computing): two cashiers updating the same cash register balance at the same time. Both read ₹100, add ₹50 & ₹30 respectively, and write ₹150 and ₹130. The final balance is incorrect.

Mutual Exclusion: ensures only one cashier updates the register at a time, perenting conflicts.

2) Peterson's Solution vs Semaphores.

Features.	Peterson's solution	Semaphores.
Implementation complexity.	Simple s/w-based solution using flags and turn variable.	Requires OS-level support and system calls.
Hardware Dependency.	Works only on single-processor system with sequential consistency.	Works on multi-core systems, less hardware dependent.

3) Advantage of monitors over semaphores in multi-core systems.

→ Monitors encapsulate synchronization, reducing errors from manual semaphores handling.

→ Advantages: Automatic mutual exclusion avoids race conditions in multi-core systems, simplifying concurrency managment.

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4) Reader - Writer starvation & Prevention

Starvation: Writers may starve if readers continously aless the resource.

Prevention: Use a writer - priority protocol or queue - based scheduling to ensure writers eventually get access.

5) Drawback of eliminating "Hold and Wait" in deadlock prevention.

Elimination: Processes must request all resources at once.

Drawback: can lead to resource under utilization and longer waiting times, reducing system throughout.

Part - B

6) Distributed Deadlock Detection Simulation

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

a) Global wait - for Graph:

P1 → P2 → P5 → P6 → P1
P3 → P4.

b) Deadlock Detection.

Cycle exists : P1 → P2 → P5 → P6 → P1
Deadlock Processes: P1, P2, P5, P6.

c) Distributed Algorithms:

Chandy - Misra - Hass algorithms for distributed deadlock detection.

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7) Distributed file system performance.

Given : local access : 5ms.
remote access : 25ms.
remote probability : 0.3ms.

a) Expected file access time E[T] :

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

b) Caching Strategy :

→ Client-side caching - store frequently accessed remote file locally.

→ Justification - reduces repeated remote access latency and network load.

8) Checkpointing in a concurrent system.

Given : Full : 200ms
Incremental : 50ms.
RPO : 1s.

a) Optimal Mix : perform 1 full checkpoint every 1s, followed by incremental checkpoints every 250 ms.

b) Reasoning : Incremental checkpoints are faster, reducing Overhead. Full checkpoints ensure complete recovery. Combination meets RPO without blocking the system.

9) Case study - Global E-commerce platform

a) Distributed scheduling challenges:
Flash sales create sudden load spikes, uneven across regions.
Suitable Algorithms : Weighted Round Robin or Dynamic Load Balancing using Least-Loaded server.

b) Fault Tolerance strategy:

Geo - redundant deployment - replicate services across multiple data centres.

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RTO/RPO: Use synchronous replication for critical services (low RPO) and asynchronous replication for less critical services (acceptance RTO)

Result: High availability even if a region fails.