Java Multithreading: What I Have Learned

1. Creating Threads

Definition:

Threads allow concurrent execution of two or more parts of a program.

You can create threads by extending the Thread class or implementing the Runnable interface.

Example:

- Created a thread that prints a message 5 times using Thread and Runnable.

Questions Solved:

- Created and started multiple threads using Thread and Runnable.

Explored the difference between calling run() and start().

2. Thread Lifecycle

Definition:

Threads in Java go through several states: NEW, RUNNABLE, BLOCKED, WAITING, TIMED_WAITING, TERMINATED.

Example:

- Used getState() to observe lifecycle transitions.

Questions Solved:

- Observed state transitions of a thread using print statements and sleep().

3. Race Conditions & Synchronization

Definition:

Race conditions occur when multiple threads access shared data without proper synchronization.

Example:

- Incremented a shared counter with and without synchronization to show inconsistent results.

Questions Solved:

- Counter increment simulation with and without synchronized keyword.

4. ReentrantLock & tryLock()

Definition:

ReentrantLock provides more control than synchronized blocks. tryLock() allows timed lock attempts.

Example:

- Simulated bank transactions with tryLock to avoid deadlocks.

Questions Solved:

- Implemented bank account transfers using ReentrantLock and tryLock().

5. Producer-Consumer Problem

Definition:

A classic concurrency problem where producer threads generate data and consumer threads consume it.

Examples:

- Implemented using:
  - wait()/notify()
  - ReentrantLock + Condition
  - BlockingQueue

Questions Solved:

- Multiple variations of producer-consumer with 1-to-1 and multi-threaded support.

6. CountDownLatch

Definition:

Used to delay the progress of threads until other threads finish certain tasks.

Example:

- Simulated exam start scenario where main thread waited for students to be ready.

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Questions Solved:

- Exam system with 3 students.

- Assignment: Restaurant opens when 3 chefs are ready.

7. CyclicBarrier

Definition:

Used to make a group of threads wait for each other to reach a common barrier point.

Example:

- Simulated a 3-player race where all players start only after all are ready.

Questions Solved:

- Race simulation using CyclicBarrier.

- Assignment: Players wait at start line and run together.

8. Semaphore

Definition:

Semaphore controls access to a resource with limited permits.

Example:

- Printer simulation where only 2 employees can print at a time.

Questions Solved:

- Printer resource controlled with Semaphore.

- Assignment: Simulated printer queue with 10 employees.

9. Exchanger

Definition:

Exchanger allows two threads to exchange data at a synchronization point.

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Example:

- Two friends exchanging shopping items (Chocolates and Biscuits).

Questions Solved:

- Exchanged lists of items using Exchanger.
- Assignment: Simulated item swap with detailed object exchange.