Assignment – 19

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Task 1:

Creating and Managing Threads:

Write a program that starts two threads, where each thread prints numbers from 1 to 10 with a 1-second delay between each number.

Program:

```
class MyThread extends Thread{

	@Override
	public void run() {
		for(int i=1;i<=10;i++) {
			System.out.print(i+" ");
			try {
				Thread.sleep(1000);
			} catch (InterruptedException e) {
				e.printStackTrace();
			}
		}
		System.out.println();
	}

}

public class CreatingAndManagingThreads {

	public static void main(String[] args) {
		MyThread thread1=new MyThread();
		MyThread thread2=new MyThread();

		thread1.start();
		thread2.start();

		try {
			thread1.join();
			thread2.join();
		} catch (InterruptedException e) {
```

```
                e.printStackTrace();
            }
            System.out.println("Both treads have finished!");
        }

}
```

Output:

1 1 2 2 3 3 4 4 5 5 6 6 7 7 8 8 9 9 10 10

Both treads have finished!

Task 2:

States and Transitions:

Create a Java class that simulates a thread going through different lifecycle states: NEW, RUNNABLE, WAITING, TIMED_WAITING, BLOCKED, and TERMINATED. Use methods like sleep(), wait(), notify(), and join() to demonstrate these states.

Program:

```
public class StatesAndTransitionsInThreads {
    public static void main(String[] args) {
        MyThreadClass thread = new MyThreadClass();
        thread.start();
        try {
            Thread.sleep(1000);
            synchronized (thread) {
                thread.notifyAll();
            }
            thread.join();
        } catch (InterruptedException e) {
            e.printStackTrace();
        }
        System.out.println("Main thread is eisting!");
    }
}
class MyThreadClass extends Thread {
    public void run() {
        try {
            System.out.println("Thread is in NEW state");
```

```
                System.out.println("Thread is in RUNNABLE state");
                Thread.sleep(3000);
                System.out.println("Thread is in TIMED_WAITING
                                        state");
                Thread.sleep(2000);
                synchronized (this) {
                        System.out.println("Thread is in WAITING
                                                state");
                        wait(2000);
                }
                System.out.println("Thread is in BLOCKED state");
                Thread.sleep(2000);
            } catch (InterruptedException e) {
                e.printStackTrace();
            }
            System.out.println("Thread is in TERMINATED state");
        }
}
```

Output:

```
Thread is in NEW state
Thread is in RUNNABLE state
Thread is in TIMED_WAITING state
Thread is in WAITING state
Thread is in BLOCKED state
Thread is in TERMINATED state
Main thread is eisting!
```

Task 3:

Synchronization and Inter-thread Communication:

Implement a producer-consumer problem using wait() and notify() methods to handle the correct processing sequence between threads.

Program:

```
import java.util.LinkedList;
public class Producer extends Thread{
        private final LinkedList<Integer> buffer;
        private final int capacity;
        private int value=0;
        public Producer(LinkedList<Integer> buffer, int capacity) {
                this.buffer = buffer;
                this.capacity = capacity;
```

```
	}
	public void run() {
		while(true) {
			try {
				synchronized (buffer) {
					while(buffer.size() == capacity) {
						System.out.println("Buffer is full.
							Producer is waiting...");
						buffer.wait();
					}
					System.out.println("Producer produsedd:
								"+value);
					buffer.add(value++);
					buffer.notify();
					Thread.sleep(1000);
				}
			} catch (InterruptedException e) {
				e.printStackTrace();
			}
		}
	}
}
public class Consumer extends Thread {

	private final LinkedList<Integer> buffer;

	public Consumer(LinkedList<Integer> buffer) {
		this.buffer = buffer;
	}
	public void run() {
		while (true) {
			try {
				synchronized (buffer) {
					while (buffer.isEmpty()) {
						System.out.println("Buffer is
						empty. Consumer is waiting...");
						buffer.wait();
					}
				int value = buffer.removeFirst();
				System.out.println("Consumer consumed: "
```

```
                                + value);
                        buffer.notify();
                        Thread.sleep(1000);
                    }
                    } catch (InterruptedException e) {
                        e.printStackTrace();
                    }
                }
            }
}
public class ProducerConsumerProblem {
    public static void main(String[] args) {
        LinkedList<Integer> buffer=new LinkedList<>();
        int capacity=5;
        Producer producer=new Producer(buffer, capacity);
        Consumer consumer=new Consumer(buffer);
        producer.start();
        consumer.start();
    }

}
```

Output:

```
Producer produsued: 0
Producer produsued: 1
Producer produsued: 2
Producer produsued: 3
Producer produsued: 4
Buffer is full. Producer is waiting...
Consumer consumed: 0
Consumer consumed: 1
Consumer consumed: 2
Consumer consumed: 3
Consumer consumed: 4
Buffer  is empty. Consumer is waiting...
Producer produsued: 5
Producer produsued: 6
Producer produsued: 7
Producer produsued: 8
Producer produsued: 9
Buffer is full. Producer is waiting...
```

```
Consumer consumed: 5
Producer produsedd: 10
Buffer is full. Producer is waiting...
Consumer consumed: 6
Consumer consumed: 7
Consumer consumed: 8
Producer produsedd: 11
Producer produsedd: 12
Producer produsedd: 13
Buffer is full. Producer is waiting...
Consumer consumed: 9
Producer produsedd: 14
Buffer is full. Producer is waiting...
Consumer consumed: 10
Consumer consumed: 11
Consumer consumed: 12
```

Task 4:

Synchronized Blocks and Methods:

Write a program that simulates a bank account being accessed by multiple threads to perform deposits and withdrawals using synchronized methods to prevent race conditions.

Program:

```
public class SynchronizedBlocksAndMethods {
	private double balance;
	public SynchronizedBlocksAndMethods(double initialBalance) {
		this.balance = initialBalance;
	}
	public synchronized void deposit(double amount) {
		balance += amount;
		System.out.println("Deposited: " + amount + ",
					New Balance: " + balance);
	}
	public synchronized void withdraw(double amount) {
		if (balance >= amount) {
			balance -= amount;
			System.out.println("Withdrawn: " + amount + ",
						New Balance: " + balance);
		} else {
			System.out.println("Insufficient funds for
						withdrawal: " + amount);
```

```
        }
    }
    public static void main(String[] args) {
        SynchronizedBlocksAndMethods account = new
                                    SynchronizedBlocksAndMethods(1000);
        Thread depositThread = new Thread(() -> {
            for (int i = 0; i < 5; i++) {
                account.deposit(100);
                try {
                    Thread.sleep(100);
                } catch (InterruptedException e) {
                    e.printStackTrace();
                }
            }
        });
        Thread withdrawThread = new Thread(() -> {
            for (int i = 0; i < 5; i++) {
                account.withdraw(200);
                try {
                    Thread.sleep(100);
                } catch (InterruptedException e) {
                    e.printStackTrace();
                }
            }
        });
        depositThread.start();
        withdrawThread.start();
        try {
            depositThread.join();
            withdrawThread.join();
        }
        catch (InterruptedException e) {
            e.printStackTrace();
        }
        System.out.println("Available Balance: "
                                    + account.balance);
    }
}
```

Output:

Deposited: 100.0, New Balance: 1100.0

Withdrawn: 200.0, New Balance: 900.0
Withdrawn: 200.0, New Balance: 700.0
Deposited: 100.0, New Balance: 800.0
Withdrawn: 200.0, New Balance: 600.0
Deposited: 100.0, New Balance: 700.0
Withdrawn: 200.0, New Balance: 500.0
Deposited: 100.0, New Balance: 600.0
Withdrawn: 200.0, New Balance: 400.0
Deposited: 100.0, New Balance: 500.0
Available Balance: 500.0

Task 5:

Thread Pools and Concurrency Utilities:

Create a fixed-size thread pool and submit multiple tasks that perform complex calculations or I/O operations and observe the execution.

Program:

```
import java.util.concurrent.ExecutorService;
import java.util.concurrent.Executors;
public class ThreadPoolsAndConcurrencyUtilities {
        public static void main(String[] args) {
            ExecutorService executor =
                                                Executors.newFixedThreadPool(3);
            for (int i = 0; i < 10; i++) {
                final int taskNumber = i;
                executor.submit(() -> {
                    System.out.println("Task " + taskNumber +
      " started by Thread: " + Thread.currentThread().getName());
                    performTask(taskNumber);
                    System.out.println("Task " + taskNumber + " completed by
Thread: " + Thread.currentThread().getName());
                });
            }
            executor.shutdown();
        }
        private static void performTask(int taskNumber) {
            try {
                Thread.sleep(1000);
            } catch (InterruptedException e) {
                e.printStackTrace();
            }
```

```
        }
}
```

Output:

```
Task 0 started by Thread: pool-1-thread-1
Task 1 started by Thread: pool-1-thread-2
Task 2 started by Thread: pool-1-thread-3
Task 0 completed by Thread: pool-1-thread-1
Task 1 completed by Thread: pool-1-thread-2
Task 2 completed by Thread: pool-1-thread-3
Task 3 started by Thread: pool-1-thread-3
Task 4 started by Thread: pool-1-thread-2
Task 5 started by Thread: pool-1-thread-1
Task 3 completed by Thread: pool-1-thread-3
Task 6 started by Thread: pool-1-thread-3
Task 4 completed by Thread: pool-1-thread-2
Task 7 started by Thread: pool-1-thread-2
Task 5 completed by Thread: pool-1-thread-1
Task 8 started by Thread: pool-1-thread-1
Task 6 completed by Thread: pool-1-thread-3
Task 9 started by Thread: pool-1-thread-3
Task 7 completed by Thread: pool-1-thread-2
Task 8 completed by Thread: pool-1-thread-1
Task 9 completed by Thread: pool-1-thread-3
```

Task 6:

Executors, Concurrent Collections, CompletableFuture:

Use an ExecutorService to parallelize a task that calculates prime numbers up to a given number and then use CompletableFuture to write the results to a file asynchronously.

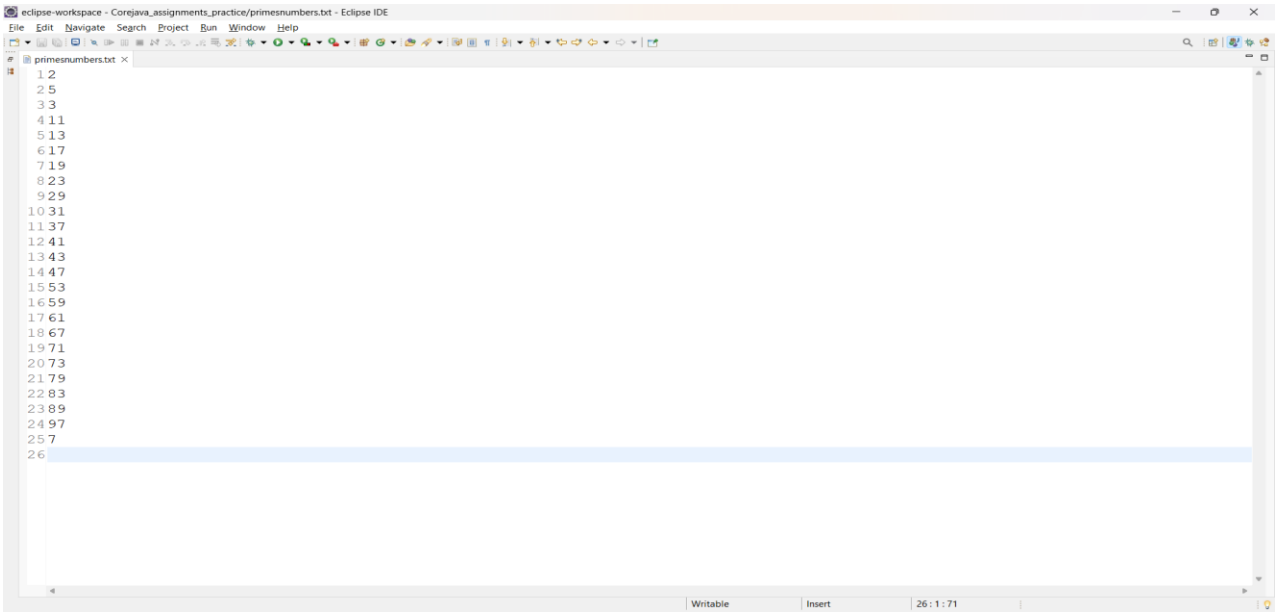
Program:

```
import java.io.BufferedWriter;
import java.io.FileWriter;
import java.io.IOException;
import java.util.ArrayList;
import java.util.List;
import java.util.concurrent.CompletableFuture;
import java.util.concurrent.ExecutorService;
```

```
import java.util.concurrent.Executors;
public class CalculatesPrimeNumbers {
	public static void main(String[] args) {
		int primecount = 100;
		ExecutorService executor =
				Executors.newFixedThreadPool
					(Runtime.getRuntime().availableProcessors());
		CompletableFuture<List<Integer>> primeNumbersFuture =
				CompletableFuture.supplyAsync(() ->
				 calculatePrimes(primecount, executor), executor);
		primeNumbersFuture.thenAcceptAsync(primeNumbers ->
			{
			writeToFile(primeNumbers);
			}).thenRun(executor::shutdown);
	}
	public static List<Integer> calculatePrimes(int primecount,
				 ExecutorService executor) {
		List<Integer> primes = new ArrayList<>();
		List<CompletableFuture<Void>> futures = new ArrayList<>();
		for (int i = 2; i <= primecount; i++) {
			int n = i;
			CompletableFuture<Void> future =
				CompletableFuture.supplyAsync(() -> {
				if (isPrime(n)) {
					synchronized (primes) {
						primes.add(n);
					}
				}
				return null;
			}, executor);
			futures.add(future);
		}
		CompletableFuture<Void> allFutures =
			 CompletableFuture.allOf(futures.toArray
				(new CompletableFuture[0]));
		allFutures.join();
		return primes;
	}
	public static boolean isPrime(int num) {
		if (num <= 1) {
```

```
                return false;
            }
            for (int i = 2; i <= Math.sqrt(num); i++) {
                if (num % i == 0) {
                    return false;
                }
            }
            return true;
        }
        public static void writeToFile(List<Integer> primes) {
            try (BufferedWriter writer = new BufferedWriter(new
FileWriter("primesnumbers.txt"))) {
                for (int prime : primes) {
                    writer.write(prime + "\n");
                }
            } catch (IOException e) {
                e.printStackTrace();
            }
        }
}
```

Output:



Task 7:

Writing Thread-Safe Code, Immutable Objects:

Design a thread-safe Counter class with increment and decrement methods. Then demonstrate its usage from multiple threads. Also, implement and use an immutable class to share data between threads.

Program:

```
import java.util.concurrent.locks.Lock;
import java.util.concurrent.locks.ReentrantLock;

class Counter {

	private int count;
	private final Lock lock;

	public Counter() {
		count = 0;
		lock = new ReentrantLock();
	}
	public void increment() {
		lock.lock();
		try {
			count++;
		} finally {
			lock.unlock();
		}
	}
	public void decrement() {
		lock.lock();
		try {
			count--;
		} finally {
			lock.unlock();
		}
	}
	public int getCount() {
		lock.lock();
		try {
			return count;
		} finally {
			lock.unlock();
```

```
                }
        }
}
final class Data {
        private final String value;

   public Data(String value) {
      this.value = value;
   }
   public String getValue() {
      return value;
   }
}

public class ThreadSafeAndImmutableOdjects {

        public static void main(String[] args) {
                final Counter counter = new Counter();
                final Data data = new Data("Hello, World!");
                Thread thread1 = new Thread(() -> {
                        for (int i = 0; i < 10; i++) {
                                counter.increment();
                        }
                });
                Thread thread2 = new Thread(() -> {
                        for (int i = 0; i < 10; i++) {
                                counter.decrement();
                        }
                });
                Thread thread3 = new Thread(() -> {
                        for (int i = 0; i < 10; i++) {
                                System.out.println("Data: " + data.getValue());
                        }
                });
                thread1.start();
                thread2.start();
                thread3.start();
                try {
                        thread1.join();
                        thread2.join();
```

```
                thread3.join();
            } catch (InterruptedException e) {
                e.printStackTrace();
            }
            System.out.println("Final Count: " + counter.getCount());
        }
}
```

Output:

```
Data: Hello, World!
Data: Hello, World!
Data: Hello, World!
Data: Hello, World!
Data: Hello, World!
Data: Hello, World!
Data: Hello, World!
Data: Hello, World!
Data: Hello, World!
Data: Hello, World!
Final Count: 0
```