**Operating Systems – COC 3071L**

**SE 5th A – Fall 2025**

# Lab 4: Introduction to Threads

## 1. Introduction to Threads

**1.1 What is a Thread?**

A **thread** is the smallest unit of execution within a process.

A **process** can have multiple threads running concurrently

All threads within a process share:

Memory space (code, data, heap)

File descriptors

Process ID

Each thread has its own:

Thread ID (TID)

Stack

Program counter

Register set

**Real-world analogy:**

**Process** = A restaurant kitchen

**Threads** = Multiple cooks working together in the same kitchen, sharing ingredients and equipment

### 1.2 Threads vs Processes – Quick Comparison

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| --- | --- | --- |
| **Feature** | **Process** | **Thread** |
| Memory | Separate memory space | Shared memory space |
| Creation | Expensive (fork) | Lightweight (pthread\_create) |
| Communication | IPC needed (pipes, etc.) | Direct (shared variables) |
| Context Switch | Slower | Faster |
| Independence | Fully independent | Dependent on parent process |

**When to use threads?**

When tasks need to share data frequently

For parallel execution within the same application

When you need lightweight concurrency

## 2. POSIX Threads (pthreads) Library

In Linux, we use the **POSIX threads (pthreads)** library for thread programming.

### 2.1 Compilation Requirements

When compiling programs with threads, you **must** link the pthread library:

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flag links the pthread library.

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## 3. C Programs with Threads

### Program 1: Creating a Simple Thread

**Objective:** Create a thread and print messages from both main thread and new thread.



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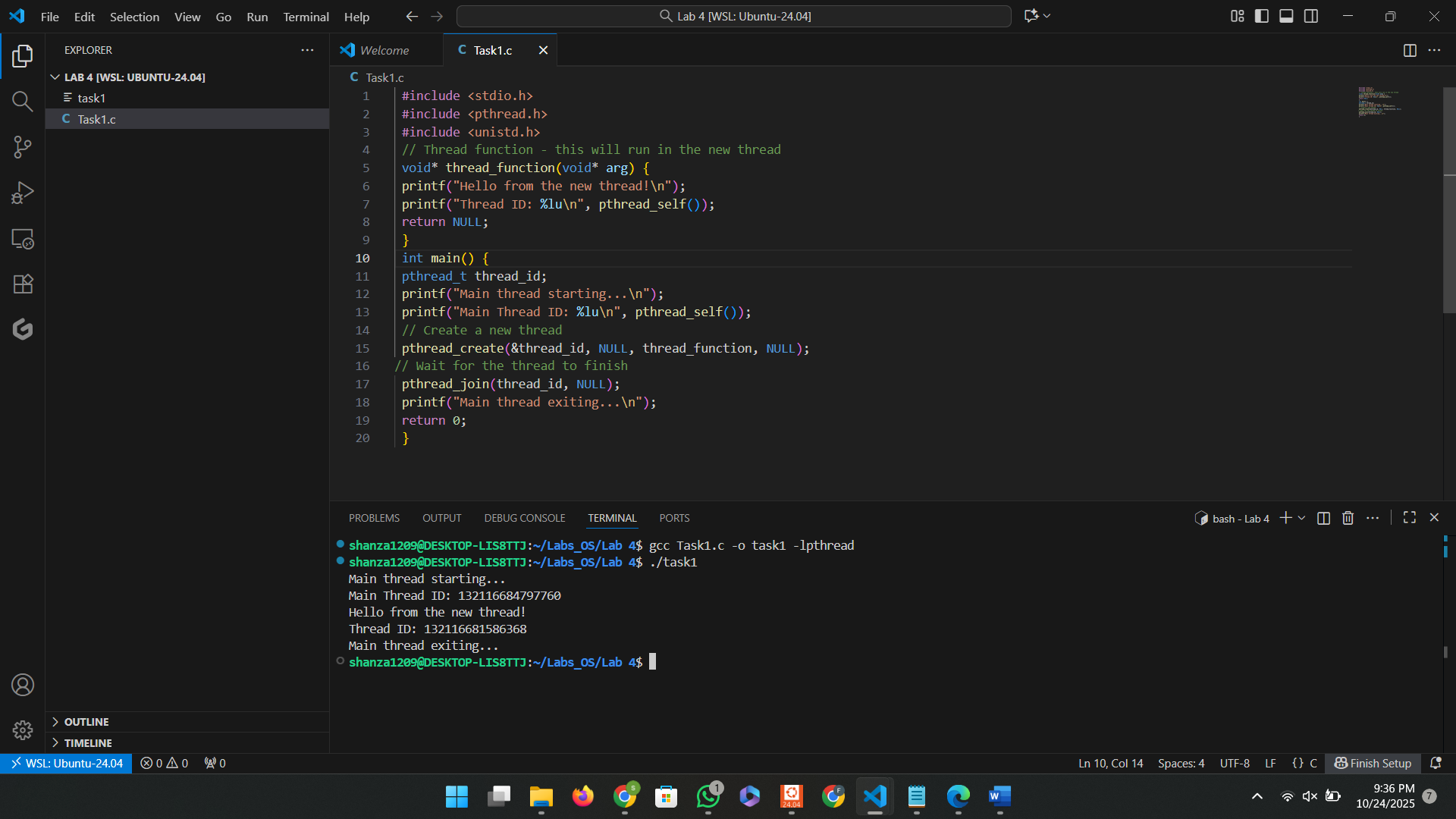
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**Explanation:**

**pthread\_t thread\_id**

This creates a **variable** to hold the thread’s ID (like a file descriptor or process ID).

It’s just a handle the OS uses to manage the thread.

#### pthread\_create(&thread\_id, NULL, thread\_function, NULL)`

Let’s decode the four parameters:

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| --- | --- | --- |
| **Parameter** | **Type** | **Meaning** |
| &thread | pthread\_t\* | Where the new thread ID will be stored |
| NULL | pthread\_attr\_t\* | Thread attributes (priority, stack size, etc.)  — NULL means default |
| myThread | void\* (\*start\_routine) (void\*) | Function to run in the new thread |
| NULL | void\* | Pointer passed to the function for data |

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→ Waits for thread to finish (like

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→ Returns the thread ID of calling thread

### Program 2: Passing Arguments to Threads

**Objective:** Pass data to a thread function.

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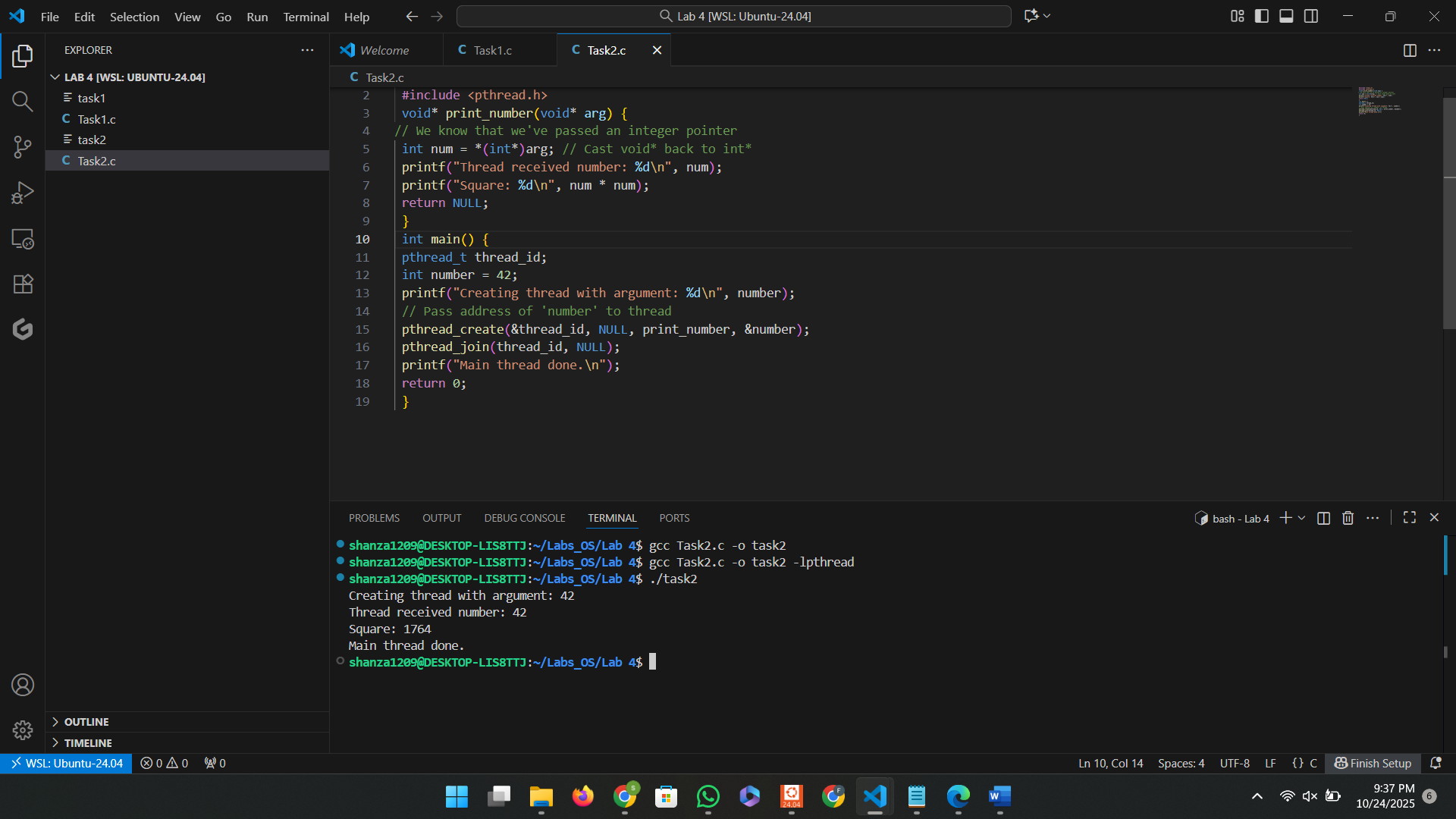
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**Important Notes:**

The 4th argument of pthread\_create() is passed to the thread function

It's a void\* pointer, so you can pass any data type

Remember to cast it properly inside the thread function Here’s what happens step by step:

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— dereference the pointer to get the integer value it points to.

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That’s because threads can accept *any* data type — integers, structs, arrays, etc.

void\* acts like a universal pointer type.

If you need to pass multiple variables, you wrap them in a

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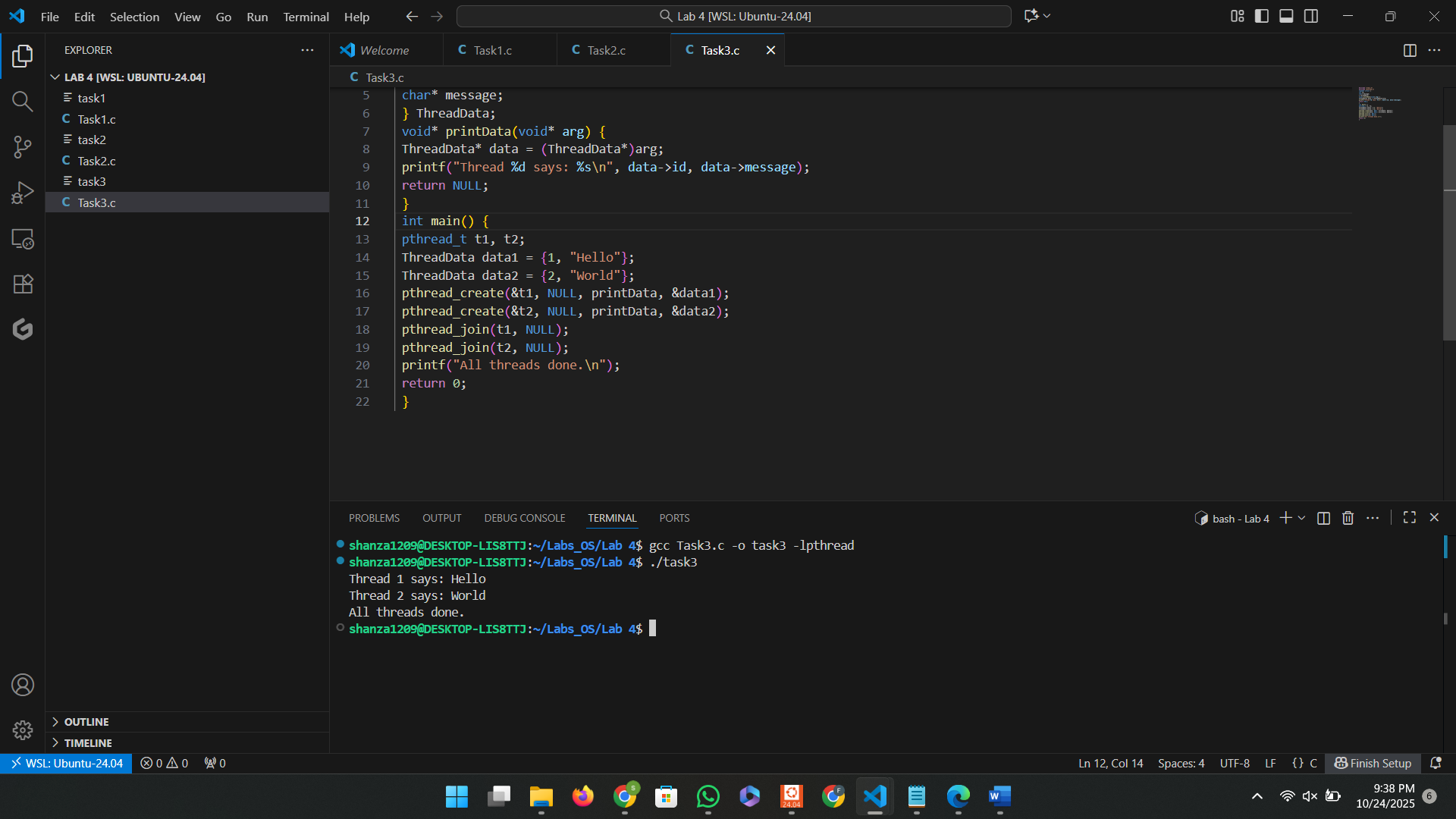
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and pass a pointer to it.

### Program 3: Passing Multiple Data





### Program 4: Multiple Threads

**Objective:** Create multiple threads executing the same function.

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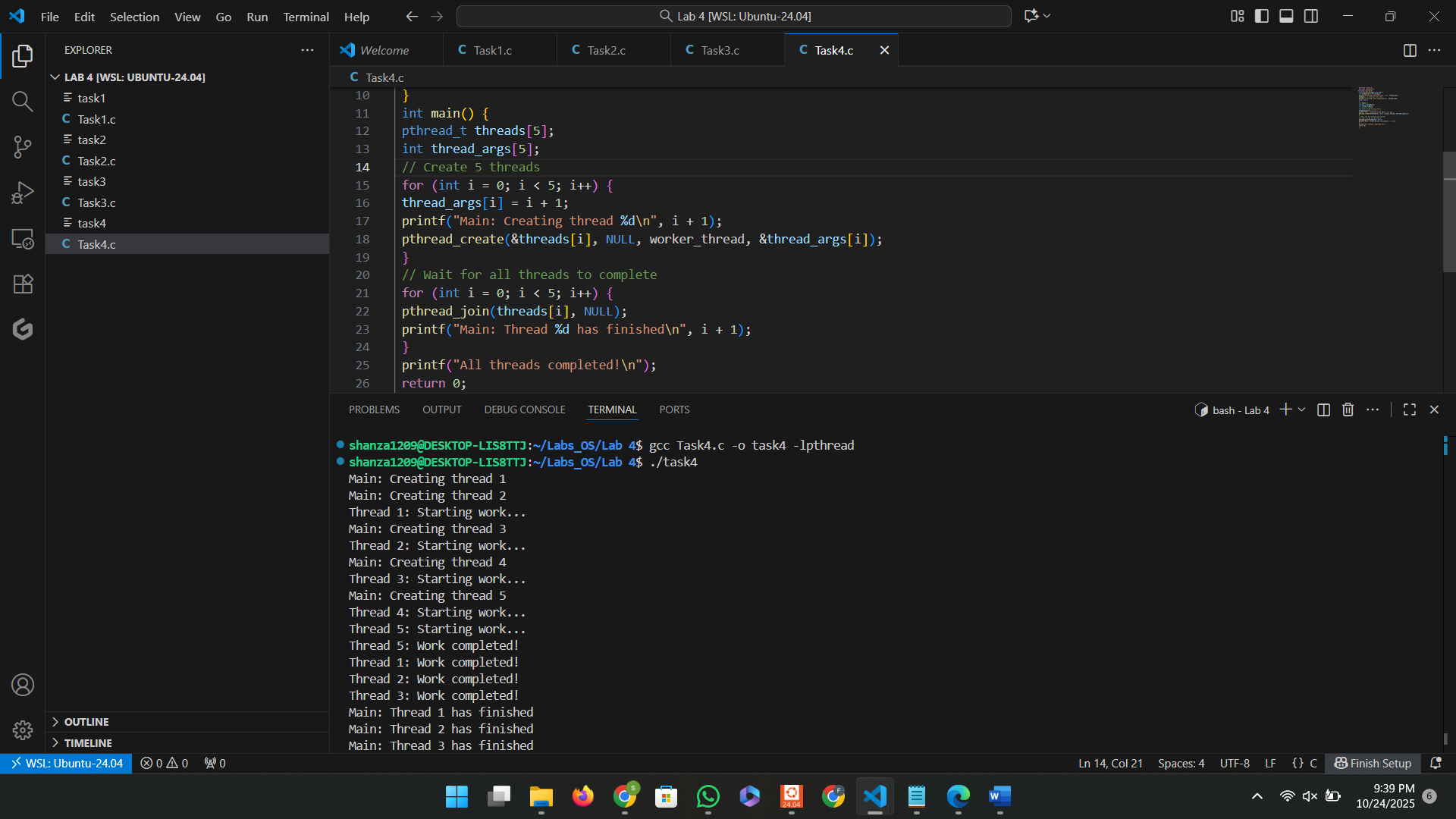
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**Observation:**

Notice how threads may not execute in order

All threads run concurrently

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ensures we wait for all threads

### Program 5: Thread Return Values

**Objective:** Get return values from threads.



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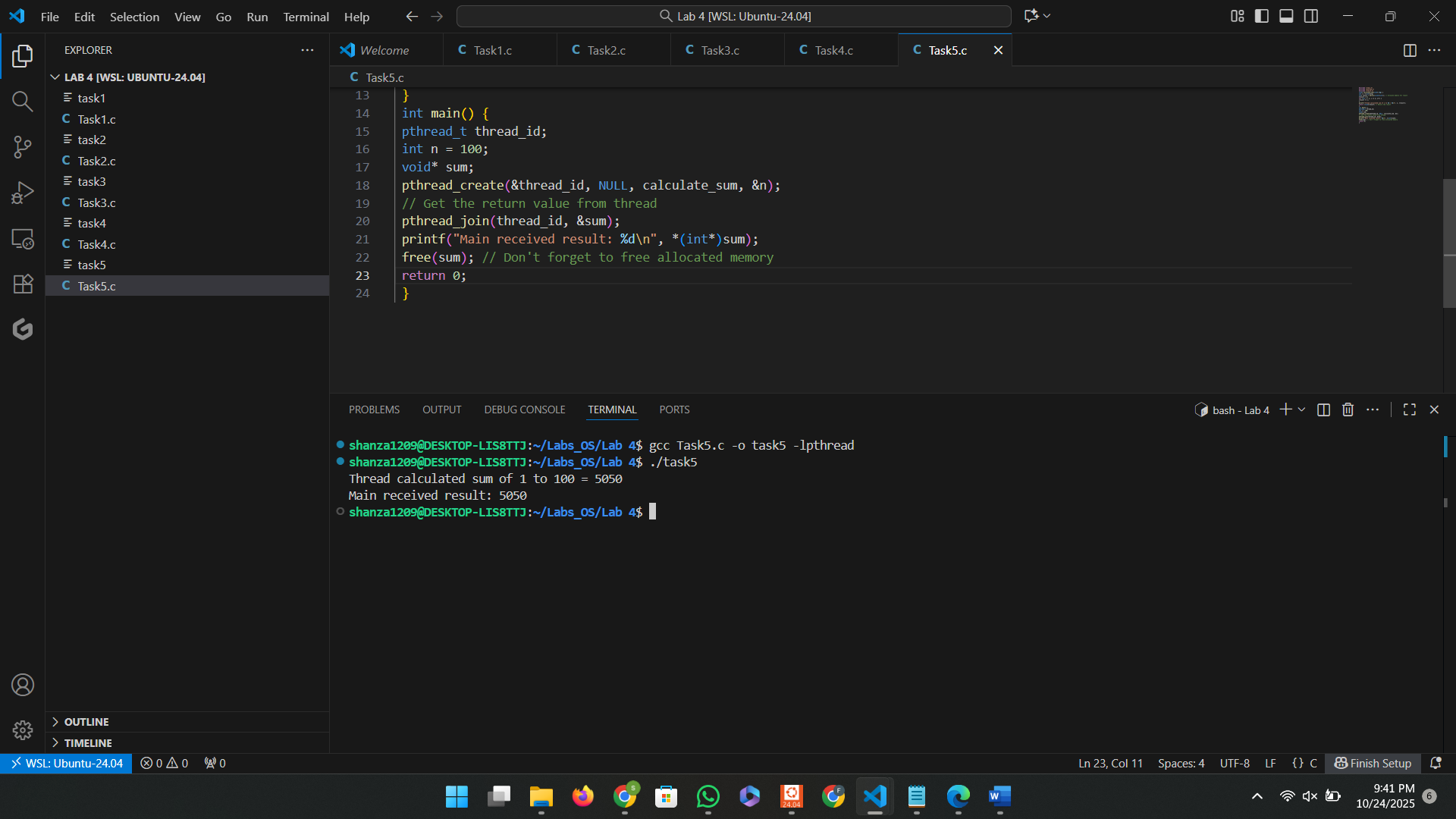
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**Key Points:**

Thread functions return void\*

Use pthread\_join() to retrieve the return value

Remember to free any dynamically allocated memory

## 5. Hands-on Practice Exercises

### Exercise 1: Thread Basics

Write a program that:

1. Creates 3 threads
2. Each thread prints its thread ID and a unique message
3. Main thread waits for all threads to complete

### Exercise 2: Prime Number Checker

Write a program that:

1. Takes a number as input
2. Creates a thread that checks if the number is prime
3. Returns the result to the main thread
4. Main thread prints whether the number is prime or not