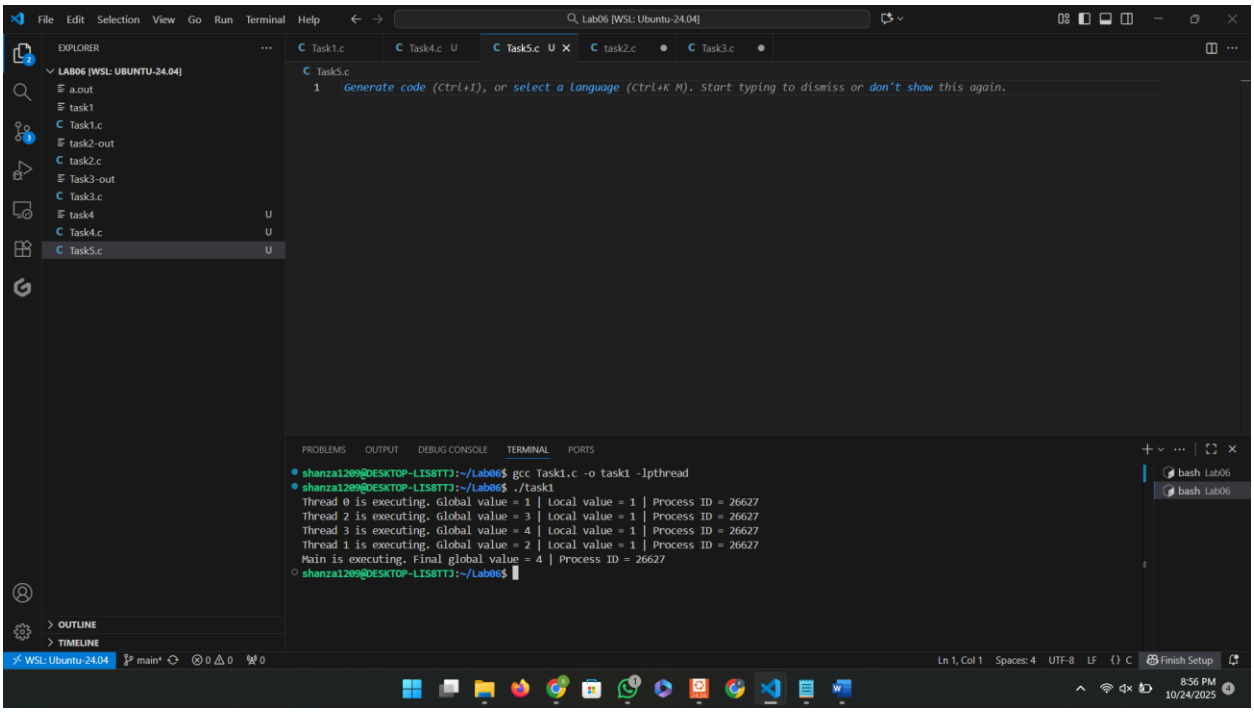
Task1:

Code:

```
#include <stdio.h>
#include <pthread.h>
#include <unistd.h>   // ☑ getpid() ke liye include karna zaroori hai

#define NUM_THREADS 4
int varg = 0;

void *thread_function(void *arg) {
   int thread_id = *(int *)arg;

   int varl = 0;
   varg++;   // global variable increment
   varl++;   // local variable increment
   printf("Thread %d is executing. Global value = %d | Local value = %d | Process ID = %d\n",
          thread_id, varg, varl, getpid());
   return NULL;
}

int main() {
   pthread_t threads[NUM_THREADS];
   int thread_args[NUM_THREADS];

   for (int i = 0; i < NUM_THREADS; ++i) {
      thread_args[i] = i;
      pthread_create(&threads[i], NULL, thread_function, &thread_args[i]);
   }
```

```
  for (int i = 0; i < NUM_THREADS; ++i) {
      pthread_join(threads[i], NULL);
  }

  printf("Main is executing. Final Global value = %d | Process ID = %d\n", varg, getpid());

  return 0;
}
```



Task2:

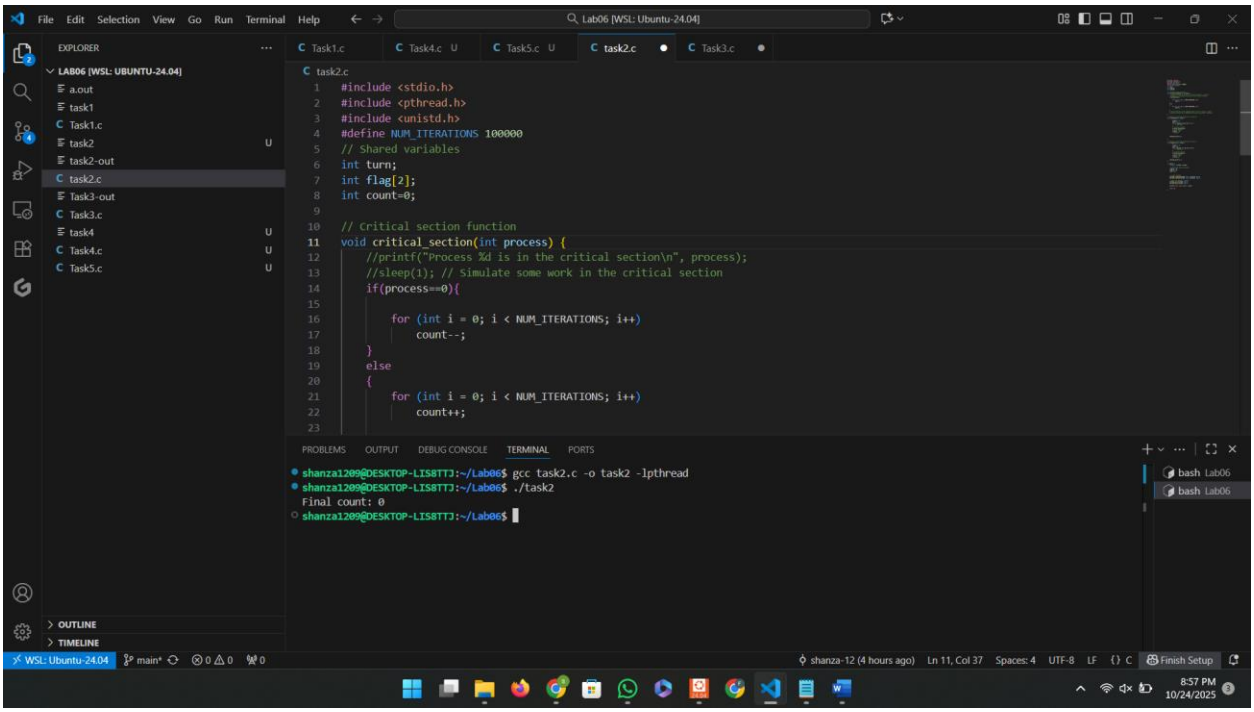
Code:

```
#include <stdio.h>

#include <pthread.h>

#include <unistd.h>

#define NUM_ITERATIONS 1000000
```

```
int count=10;


// Critical section function
void critical_section(int process) {
  //printf("Process %d is in the critical section\n", process);
  //sleep(1); // Simulate some work in the critical section
  if(process==0){

    for (int i = 0; i < NUM_ITERATIONS; i++)
    count--;
  }
  else
  {
    for (int i = 0; i < NUM_ITERATIONS; i++)
    count++;
  }

}

void *process0(void *arg) {


    // Critical section
    critical_section(0);
    // Exit section


```

```
    return NULL;
}

void *process1(void *arg) {
    
    
    
    // Critical section
    critical_section(1);
    // Exit section

    
    
    
    return NULL;
}

int main() {
    pthread_t thread0, thread1, thread2, thread3;

    
    // Create threads
    pthread_create(&thread0, NULL, process0, NULL);
    pthread_create(&thread1, NULL, process1, NULL);
    pthread_create(&thread2, NULL, process0, NULL);
    pthread_create(&thread3, NULL, process1, NULL);

    // Wait for threads to finish
```

```
  pthread_join(thread0, NULL);
  pthread_join(thread1, NULL);
  pthread_join(thread2, NULL);
  pthread_join(thread3, NULL);

  printf("Final count: %d\n", count);

  return 0;
}
```



Task3:

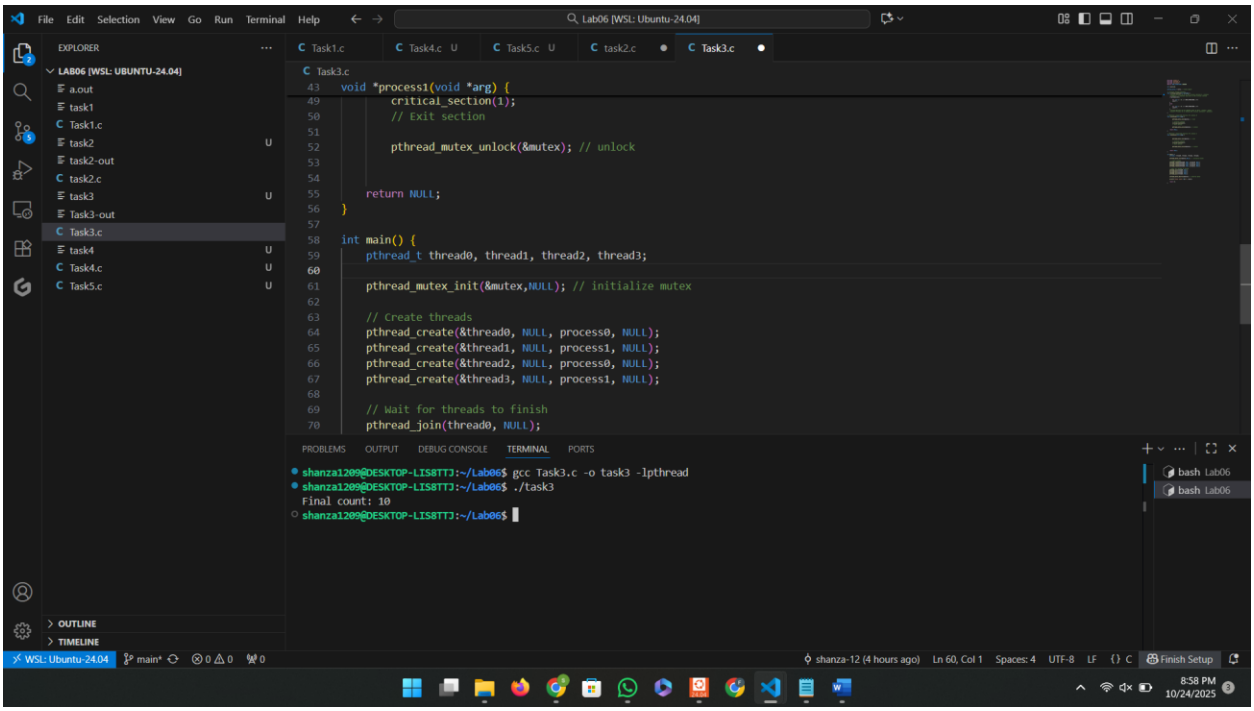
Code:

```
#include <stdio.h>
#include <pthread.h>
#include <unistd.h>
#define NUM_ITERATIONS 1000000

int count=10;

pthread_mutex_t mutex; // mutex object

// Critical section function
void critical_section(int process) {
  //printf("Process %d is in the critical section\n", process);
  //sleep(1); // Simulate some work in the critical section
  if(process==0){

     for (int i = 0; i < NUM_ITERATIONS; i++)
     count--;
  }
  else
  {
```

```
    for (int i = 0; i < NUM_ITERATIONS; i++)
    count++;
  }
  //printf("Process %d has updated count to %d\n", process, count);
  //printf("Process %d is leaving the critical section\n", process);
}

// Peterson's Algorithm function for process 0
void *process0(void *arg) {
    
    pthread_mutex_lock(&mutex); // lock

    // Critical section
    critical_section(0);
    // Exit section
   
    pthread_mutex_unlock(&mutex); // unlock
 
  return NULL;
}

// Peterson's Algorithm function for process 1
```

```
void *process1(void *arg) {
    pthread_mutex_lock(&mutex); // lock

    // Critical section
    critical_section(1);
    // Exit section

    pthread_mutex_unlock(&mutex); // unlock

  return NULL;
}

int main() {
  pthread_t thread0, thread1, thread2, thread3;

  pthread_mutex_init(&mutex,NULL); // initialize mutex

  // Create threads
  pthread_create(&thread0, NULL, process0, NULL);
```

```
    pthread_create(&thread1, NULL, process1, NULL);
    pthread_create(&thread2, NULL, process0, NULL);
    pthread_create(&thread3, NULL, process1, NULL);

    // Wait for threads to finish
    pthread_join(thread0, NULL);
    pthread_join(thread1, NULL);
    pthread_join(thread2, NULL);
    pthread_join(thread3, NULL);

    pthread_mutex_destroy(&mutex); // destroy mutex

    printf("Final count: %d\n", count);

    return 0;
}
```



Task4:

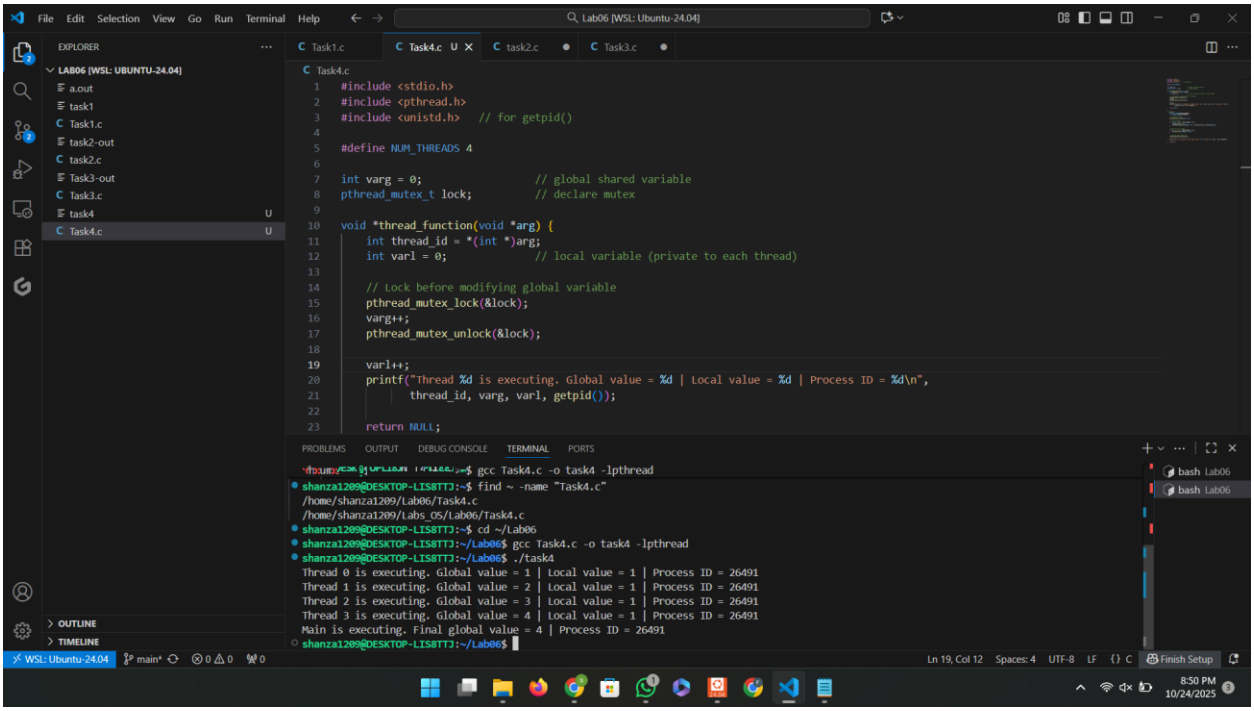
Code:

```
#include <stdio.h>

#include <pthread.h>

#include <unistd.h>


#define NUM_ITERATIONS 1000000


int count = 10;

pthread_mutex_t mutex; // mutex object


// Critical section function

void critical_section(int process) {

  if (process == 0) {

    for (int i = 0; i < NUM_ITERATIONS; i++)

        count--;
```

```
    }
    else if (process == 1) {
        for (int i = 0; i < NUM_ITERATIONS; i++)
            count++;
    }
    else if (process == 2) {
        for (int i = 0; i < NUM_ITERATIONS; i++)
            count += 2;  // third process modifies differently
    }
}

// Process 0
void *process0(void *arg) {
    pthread_mutex_lock(&mutex);   // lock
    critical_section(0);
    pthread_mutex_unlock(&mutex); // unlock
    return NULL;
}

// Process 1
void *process1(void *arg) {
    pthread_mutex_lock(&mutex);
    critical_section(1);
    pthread_mutex_unlock(&mutex);
    return NULL;
}

// ☑ Process 2 (newly added)
void *process2(void *arg) {
```

```
    pthread_mutex_lock(&mutex);
    critical_section(2);
    pthread_mutex_unlock(&mutex);
    return NULL;
}

int main() {
    pthread_t thread0, thread1, thread2, thread3, thread4, thread5;

    pthread_mutex_init(&mutex, NULL); // initialize mutex

    // Create threads for all processes
    pthread_create(&thread0, NULL, process0, NULL);
    pthread_create(&thread1, NULL, process1, NULL);
    pthread_create(&thread2, NULL, process2, NULL);
    pthread_create(&thread3, NULL, process0, NULL);
    pthread_create(&thread4, NULL, process1, NULL);
    pthread_create(&thread5, NULL, process2, NULL);

    // Wait for all threads to complete
    pthread_join(thread0, NULL);
    pthread_join(thread1, NULL);
    pthread_join(thread2, NULL);
    pthread_join(thread3, NULL);
    pthread_join(thread4, NULL);
    pthread_join(thread5, NULL);

    pthread_mutex_destroy(&mutex); // destroy mutex
```

```
  printf("Final count: %d\n", count);
  return 0;
}
```



Comparison of mutex and peterson's algorithm:

A mutex is a synchronization mechanism provided by the operating system that allows only one process or thread to access a shared resource at a time. When a process wants to enter its critical section, it locks the mutex, ensuring that no other process can enter until it is unlocked. Once the process finishes its task, it releases the mutex, allowing other processes to proceed. Mutexes are hardware- or OS-supported, making them efficient, reliable, and widely used in real-world systems for handling concurrency and preventing race conditions. A mutex is a hardware or OS-based synchronization tool that ensures only one thread enters the critical section at a time, preventing data inconsistency.

Peterson's Algorithm:

In contrast, Peterson's algorithm is a software-based solution for achieving mutual exclusion between two processes. It uses two shared variables—flag[] and turn—to coordinate which process can enter the critical section. Each process sets its flag to indicate interest in entering and assigns the turn to the other process. A process only enters its critical section when it is its turn and the other process is not interested. Peterson's algorithm is a software-based synchronization

technique that uses shared variables to ensure mutual exclusion between two processes without hardware support.