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Course	Operating system
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Lab No.	9 (After Mids.)

Lab No. 9 Operating system:

Binary Semaphores:

A binary semaphore is a synchronization mechanism in an operating system that can take only two integer **values, 0 or 1,** to control access to a single shared resource. It is primarily used to enforce **mutual exclusion**, ensuring that only one process or thread can access a critical section of code at a time, thereby preventing race conditions.

Code:

```
#include <stdio.h>
#include <pthread.h>
#include <semaphore.h>
#include <unistd.h>
sem_t mutex; // Binary semaphore
int counter = 0;
void* thread_function(void* arg) {
int id = *(int*)arg;
for (int i = 0; i < 5; i++) {
printf("Thread %d: Waiting...\n", id);
sem_wait(&mutex); // Acquire
// Critical section
counter++;
printf("Thread %d: In critical section | Counter = %d\n", id,
counter);
sleep(1);
sem_post(&mutex); // Release
sleep(1);
}
return NULL;
}
int main() {
sem_init(&mutex, 0, 1); // Binary semaphore initialized to 1
pthread_t t1, t2;
int id1 = 1, id2 = 2;
pthread_create(&t1, NULL, thread_function, &id1);
pthread_create(&t2, NULL, thread_function, &id2);
pthread_join(t1, NULL);
pthread_join(t2, NULL);
printf("Final Counter Value: %d\n", counter);
sem_destroy(&mutex);
```

```
return 0;
}
```

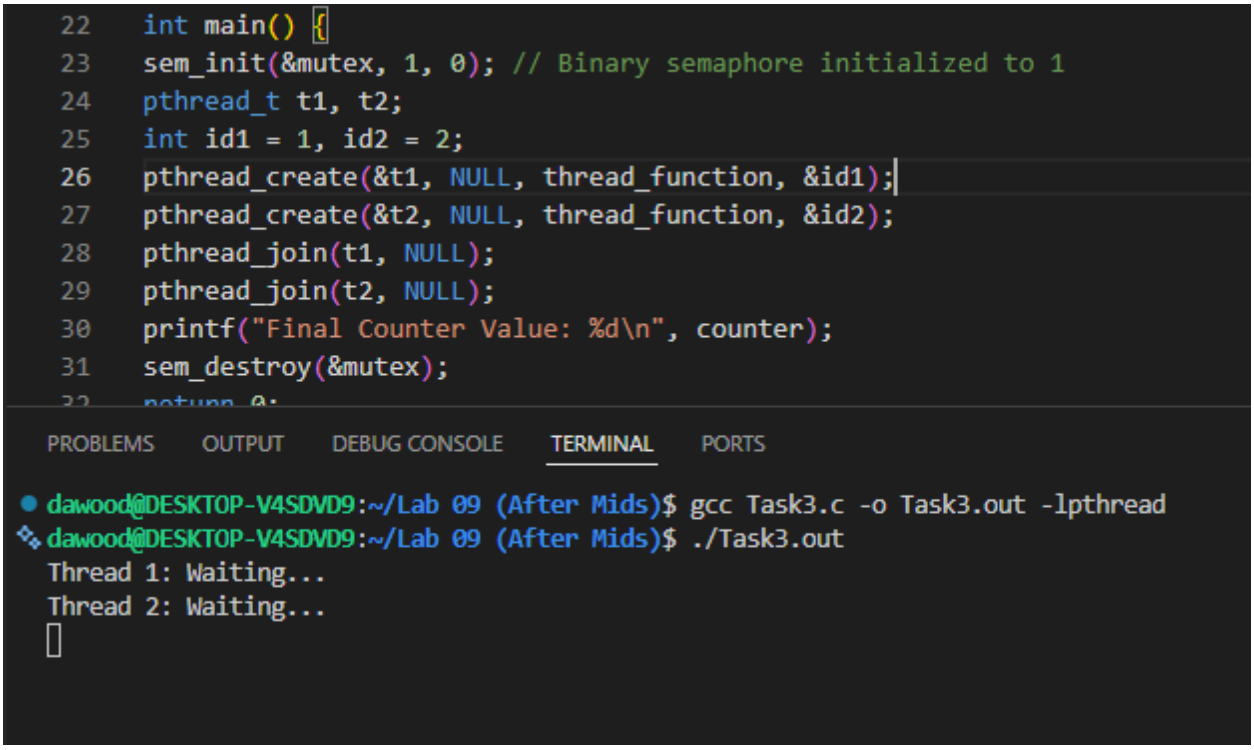
Outputs:

```
PROBLEMS  OUTPUT  DEBUG CONSOLE  TERMINAL  PORTS
dawood@DESKTOP-V4SDVD9:~/Lab 09 (After Mids)$ gcc Task3.c -o Task3.out -lpthread
dawood@DESKTOP-V4SDVD9:~/Lab 09 (After Mids)$ ./Task3.out
Thread 1: Waiting...
Thread 1: In critical section | Counter = 1
Thread 2: Waiting...
Thread 2: In critical section | Counter = 2
Thread 1: Waiting...
Thread 1: In critical section | Counter = 3
Thread 2: Waiting...
Thread 2: In critical section | Counter = 4
Thread 1: Waiting...
Thread 1: In critical section | Counter = 5
Thread 2: Waiting...
Thread 2: In critical section | Counter = 6
Thread 1: Waiting...
Thread 1: In critical section | Counter = 7
Thread 2: Waiting...
Thread 2: In critical section | Counter = 8
Thread 1: Waiting...
Thread 1: In critical section | Counter = 9
Thread 2: Waiting...
Thread 2: In critical section | Counter = 10
Final Counter Value: 10
dawood@DESKTOP-V4SDVD9:~/Lab 09 (After Mids)$
```

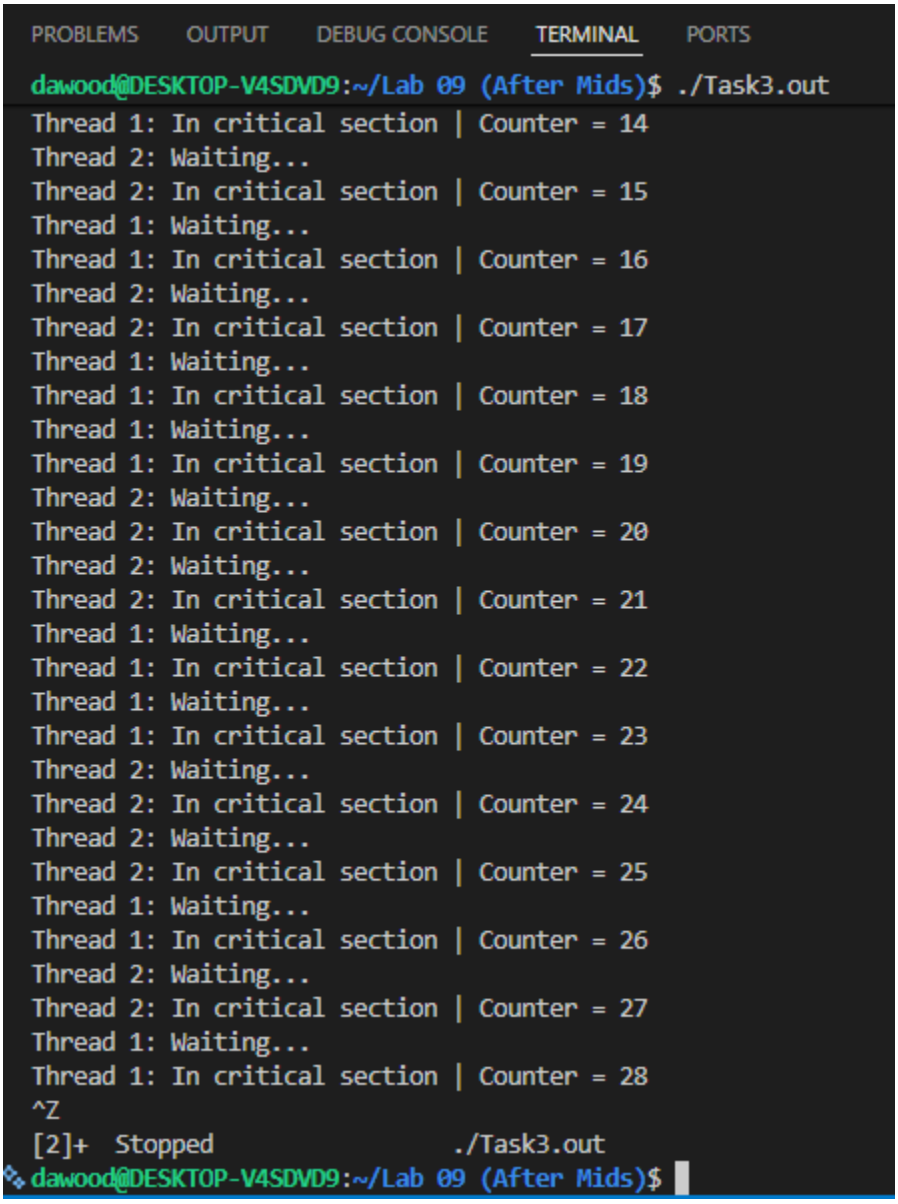
After Changing the

sem_init(&mutex, 0, 1); to sem_init(&mutex, 1, 0);

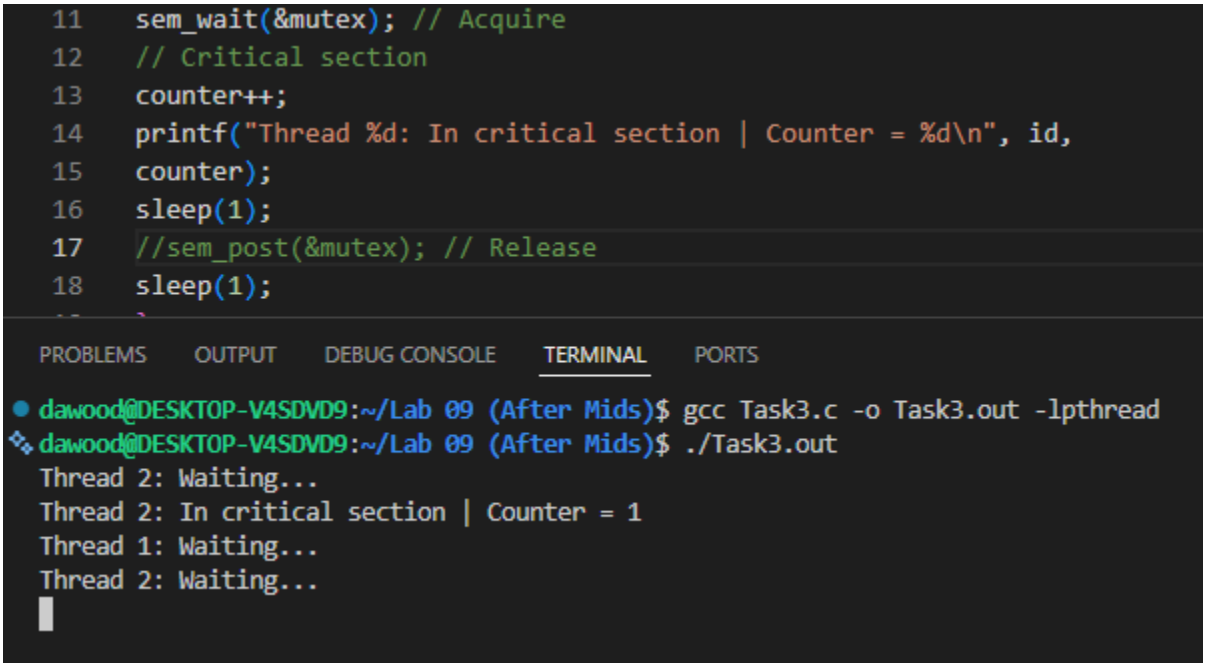
we will get:



Secondly if we comment out or remove the sem_wait statement, what will we get:



Similarly if we remove sem_post statement from code , we can see



Task 2:

Code:

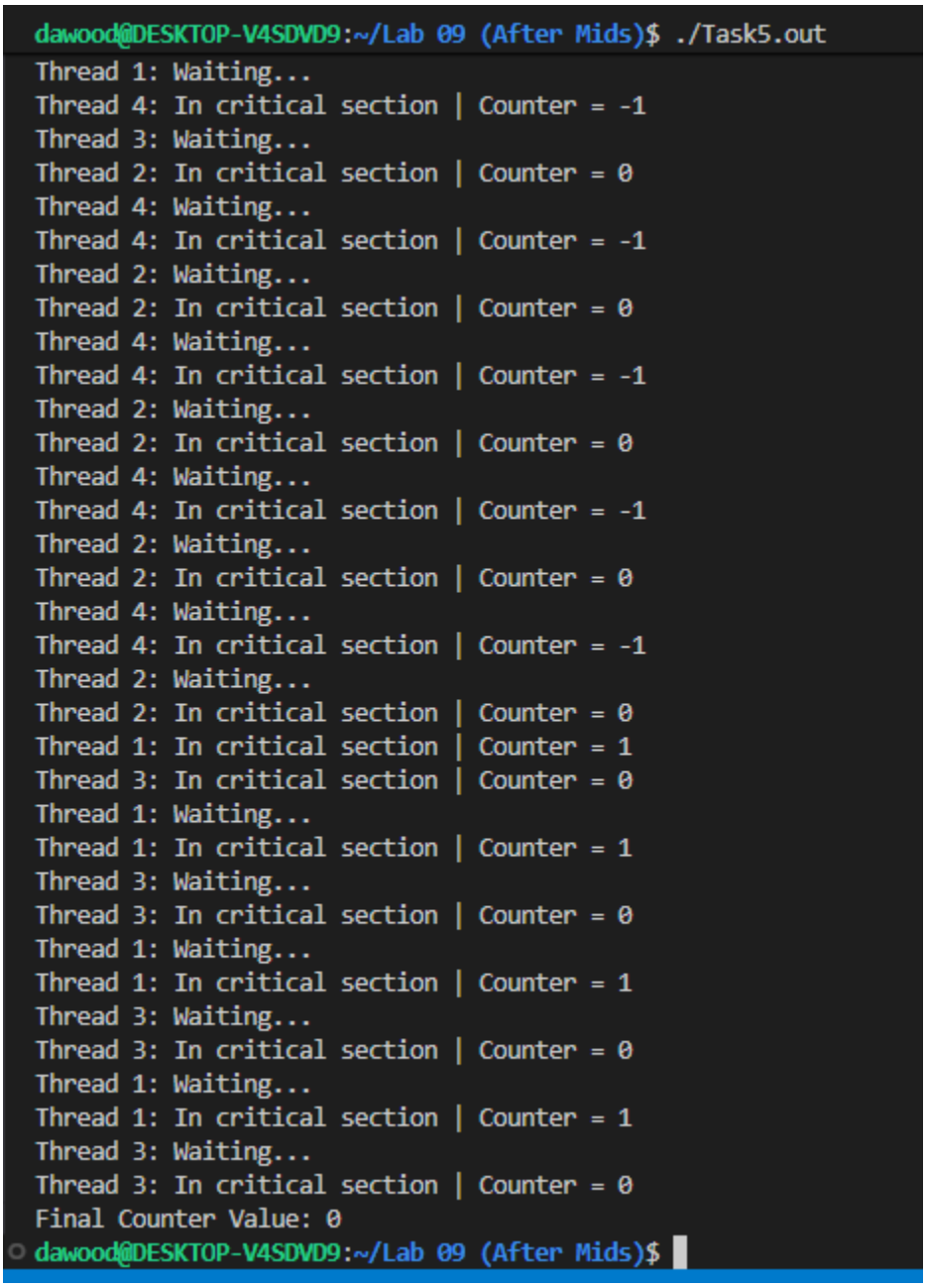
```c
#include <stdio.h>
#include <pthread.h>
#include <semaphore.h>
#include <unistd.h>
sem_t mutex; // Binary semaphore
int counter = 0;
void *thread_function(void *arg)
{
    int id = *(int *)arg;
    for (int i = 0; i < 5; i++)
    {
        printf("Thread %d: Waiting...\n", id);
        sem_wait(&mutex); // Acquire
                          // Critical section
        counter++;
        printf("Thread %d: In critical section | Counter = %d\n", id,
               counter);
        sleep(1);
        sem_post(&mutex); // Release
        sleep(1);
    }
    return NULL;
}
void *thread_function1(void *arg)
{
    int id = *(int *)arg;
    for (int i = 0; i <5;  i++)
    {
        printf("Thread %d: Waiting...\n", id);
        sem_wait(&mutex); // Acquire
                          // Critical section
        counter--;
        printf("Thread %d: In critical section | Counter = %d\n", id,
               counter);
        sleep(1);
        sem_post(&mutex); // Release
        sleep(1);
    }
    return NULL;
}
```

```c
int main()
{
    sem_init(&mutex, 0, 1); // Binary semaphore initialized to 1
    pthread_t t1,t2,t3,t4;
    int id1 = 1, id2 = 2, id3 = 3, id4 =4 ;

    pthread_create(&t1, NULL, thread_function, &id1);
    pthread_create(&t2, NULL, thread_function, &id2);
    pthread_create(&t3, NULL, thread_function1, &id3);
    pthread_create(&t4, NULL, thread_function1, &id4);
    pthread_join(t1, NULL);

    pthread_join(t2, NULL);
    pthread_join(t3, NULL);
    pthread_join(t4, NULL);
    printf("Final Counter Value: %d\n", counter);
    sem_destroy(&mutex);
    return 0;
}
```

Output Screenshot:



Task 3:

Difference Between Binary Semaphore and Mutex Lock

Feature	Binary Semaphore	Mutex
Value	0 or 1	Locked or unlocked
Ownership	**No ownership** (any thread can post)	**Ownership** (only locking thread should unlock)
Use case	Signalling + mutual exclusion	Only mutual exclusion
Danger	Incorrect `sem_post()` by any thread	Safer due to ownership
Can it wake another thread?	YES	NO (only unlocks)