National Textile University

Department of Computer Science

Subject:

Operating System

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Reg number:

23-NTU-CS-1159

Assignment Number:

2

Semester:

5th

Part#1

A counting semaphore is initialized to 7. If 10 wait() and 4 signal() operations are performed, find the final value of the semaphore.

Solution:

Applying wait():

S=7-10

S=-3

Applying signal():

S=-3+4

S=1

Final Answer:

S=1

A semaphore starts with value 3. If 5 wait() and 6 signal() operations occur, calculate the resulting semaphore value.

Solution:

Applying wait():

S=3−5

S=−2

Applying signal():

S=-2+6

S=4

Final Answer:

S=4

A semaphore is initialized to 0. If 8 signal() followed by 3 wait() operations are executed, find the final value?

Solution:

Applying wait():

S=0+8

S=8

Applying signal():

S=8-3

S=5

Final Answer:

S=5

A semaphore is initialized to 2. If 5 wait() operations are executed?

Solution:

S=2-1=1

S=1-1=0

S=0-1=-1

S=-1-1=-2

S=-2-1=-3

(a) How many processes enter the critical section?

Just first 2 process enter critical section, beacaue to enter in critical section semaphore must be <=0

(b) How many processes are blocked?

Remaining 3 process are blocked

A semaphore starts at 1. If 3 wait() and 1 signal() operations are performed?

Solution:

Applying wait():

S=1-1=0

S=0-1=-1

S=-1-1=-2

Applying signal():

S=-2+1=-1

(a) How many processes remain blocked?

1 process.

(b) What is the final semaphore value?

<u>S=-1</u>

Semaphore S = 3; wait(S); wait(S); signal(S); wait(S); wait(S)?

Solution:

Applying wait():

S=3-1=2

S=2-1=1

Applying signal():

S=1+1=2

Applying wait():

S=2-1=1

S=1-1=0

(a) How many processes enter the critical section?

4 processes.

(b) What is the final value of S?

S=0

Semaphore S = 1; wait(S); wait(S); signal(S); signal(S).

Solution:

Applying wait():

S=1-1=0

S=0-1=-1

Applying signal():

S=-1+1=0

S=0+1=1

(a) How many processes are blocked?

1 Process.

(b) What is the final value of S?

S=1

A binary semaphore is initialized to 1. Five wait() operations are executed without any signal().

Solution:

Applying wait():

S=1->0

S=0

S=0

S=0

S=0

How many processes enter the critical section?

Only one process, because to enter in critical section semaphore must be <=0.

How many are blocked?

Remaining all are blocked (4 process).

A counting semaphore is initialized to 4. If 6 processes execute wait() simultaneously?

Solution:

Applying wait():

S=4-1=3

S=3-1=2

S=2-1=1

S=1-1=0

S=0-1=-1

S=-1-1=-2

How many proceed?

First 4 process.

How many are blocked?

Last 2 process.

A semaphore S is initialized to 2. wait(S); wait(S); wait(S); signal(S); signal(S); wait(S); a) Track the semaphore value after each operation.

Solution:

Semaphore Value	**Process State**	**Blocked?**
2	NULL	N0
2-1=1	Critical Section	N0
1-1=0	Critical Section	N0
0-1=-1	Blocked	Yes
-1+1=0	Unblocks	N0
0+1=1	NULL	N0
1-1=0	Critical Section	N0

(b) How many processes were blocked at any time?

Only 1 process is blocked at wait(3).

Semaphore is initialized to 0. Three processes execute wait() before any signal(). Later, 5 signal() operations are executed.

Solution:

Applying wait():

S=0-1=-1

S=-1-1=-2

S=-2-1=-3

Applying signal():

S=-3+1=-2

S=-2+1=-1

S=-1+1=0

S=0+1=1

S=1+1=2

(a) How many processes wake up?

3 Blocked process waked up at signal().

(b) What is the final semaphore value?

<u>S=2</u>

Part#2

Code:

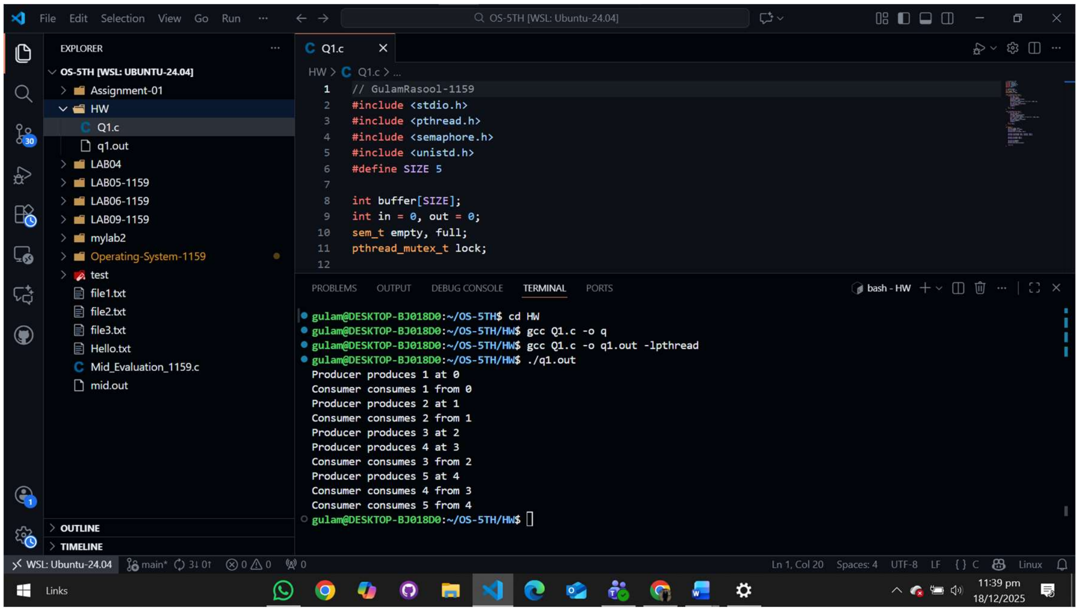
```
#include <stdio.h>
#include <pthread.h>
#include <semaphore.h>
#include <unistd.h>
#define SIZE 5

int buffer[SIZE];
int in = 0, out = 0;
sem_t empty, full;
pthread_mutex_t lock;

void* producer(void* arg) {
   for(int i=0; i<5; i++) {
      int item = i+1;
      sem_wait(&empty);
      pthread_mutex_lock(&lock);
      buffer[in] = item;
      printf("Producer produces %d at %d\n", item, in);
      in = (in+1) % SIZE;
      pthread_mutex_unlock(&lock);
      sem_post(&full);
      sleep(1);
   }
   return NULL;
}

void* consumer(void* arg) {
   for(int i=0; i<5; i++) {
      sem_wait(&full);
      pthread_mutex_lock(&lock);
      int item = buffer[out];
      printf("Consumer consumes %d from %d\n", item, out);
      out = (out+1) % SIZE;
      pthread_mutex_unlock(&lock);
      sem_post(&empty);
      sleep(2);
   }
   return NULL;
}

int main() {
```

```
    pthread_t prod, cons;
    sem_init(&empty, 0, SIZE);
    sem_init(&full, 0, 0);
    pthread_mutex_init(&lock, NULL);

    pthread_create(&prod, NULL, producer, NULL);
    pthread_create(&cons, NULL, consumer, NULL);

    pthread_join(prod, NULL);
    pthread_join(cons, NULL);

    sem_destroy(&empty);
    sem_destroy(&full);
    pthread_mutex_destroy(&lock);

    return 0;
}
```

Description:

- Create a 2 function for producer and consumer.
- Producer() create 1 item.
- Use sem_wait(&empty) check the space is empty or not, if the space is empty it put them in buffer, otherwise wait for it empty.
- Then use pthread_mutex_lock to apply synchronization.
- The item is placed in ‘in’ index of buffer.
- Then update the ‘in’ index of buffer.
- Unlock the buffer using pthread_mutex_unlock(&lock).
- Then signal the consumer by sem_post(&full).
- Consumer() takes 1 item at a time from the buffer.
- Use sem_wait(&full) to check if the buffer has an item.
- If an item exists, it is taken from the buffer.
- If not, the consumer waits until an item is produced.
- Lock the buffer using pthread_mutex_lock(&lock).
- The item from the ‘out’ index of the buffer.
- Update the out index for the next item (out = (out + 1) % SIZE).
- Unlock the buffer using pthread_mutex_unlock(&lock).
- Then signal the producer by sem_post(&full).
- In main(), Initialize semaphore and mutex lock.
- Then create a producer and consumer object.
- At last, destroy both semaphore and mutex.

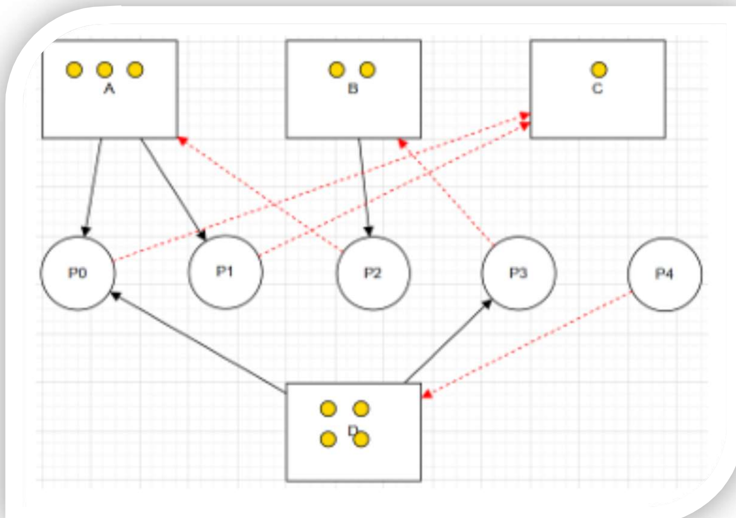
Output:



EXPLORER
OS-5TH [WSL: UBUNTU-24.04]
Assignment-01
HW
Q1.c
q1.out
LAB04
LAB05-1159
LAB06-1159
LAB09-1159
mylab2
Operating-System-1159
test
file1.txt
file2.txt
file3.txt
Hello.txt
Mid_Evaluation_1159.c
mid.out
OUTLINE
TIMELINE
// GulamRasool-1159
#include <stdio.h>
#include <pthread.h>
#include <semaphore.h>
#include <unistd.h>
#define SIZE 5
int buffer[SIZE];
int in = 0, out = 0;
sem_t empty, full;
pthread_mutex_t lock;
PROBLEMS
OUTPUT
DEBUG CONSOLE
TERMINAL
PORTS
gulam@DESKTOP-BJ018D0:~/OS-5TH$ cd HW
gulam@DESKTOP-BJ018D0:~/OS-5TH/HW$ gcc Q1.c -o q
gulam@DESKTOP-BJ018D0:~/OS-5TH/HW$ gcc Q1.c -o q1.out -lpthread
gulam@DESKTOP-BJ018D0:~/OS-5TH/HW$ ./q1.out
Producer produces 1 at 0
Consumer consumes 1 from 0
Producer produces 2 at 1
Consumer consumes 2 from 1
Producer produces 3 at 2
Producer produces 4 at 3
Consumer consumes 3 from 2
Producer produces 5 at 4
Consumer consumes 4 from 3
Consumer consumes 5 from 4
gulam@DESKTOP-BJ018D0:~/OS-5TH/HW$
WSL: Ubuntu-24.04
Ln 1, Col 20
Spaces: 4
UTF-8
LF
Linux
11:39 pm
18/12/2025

Part#3

Covert the following graph into matrix table:



Allocation Matrix:

Processes	A	B	C	D
P0	1	0	0	1
P1	1	0	0	0
P2	0	1	0	1
P3	0	0	0	0
P4	0	0	0	0

Request Matrix:

Processes	A	B	C	D
P0	0	0	1	0
P1	0	0	1	0
P2	1	0	0	1
P3	0	1	0	0
P4	0	0	0	1

Part#4

Part 4: Banker's Algorithm

System Description:

- The system comprises five processes (P0–P3) and four resources (A,B,C,D).

- Total Existing Resources:

Total			
A	B	C	D
6	4	4	2

- Snapshot at the initial time stage:

	Allocation				Max				Need			
	A	B	C	D	A	B	C	D	A	B	C	D
P0	2	0	1	1	3	2	1	1				
P1	1	1	0	0	1	2	0	2				
P2	1	0	1	0	3	2	1	0				
P3	0	1	0	1	2	1	0	1				

-

Allocation Matrix

	A	B	C	D
P0	2	0	1	1
P1	1	1	0	0
P2	1	0	1	0
P3	0	1	0	1

Max Matrix

	A	B	C	D
P0	3	2	1	1
P1	1	2	0	2
P2	3	2	1	0
P3	2	1	0	1

1. Available vector:

A.V = Total - sum of allocate

Sum of allocated

$A = 2+1+1+0 = 4$

$B = 0+1+0+1 = 2$

$C = 1+0+1+0 = 2$

$D = 1+0+0+1 = 2$

Now, apply available vector:

$A = 6 - 4 = 2$

$B = 4 - 2 = 2$

$C = 4 - 2 = 2$

$D = 2 - 2 = 0$

2. Need Matrix:

Need = Max − Allocation

	A	B	C	D
P0	3−2	2-0	1-1	1-1
P1	1-1	2-1	0-0	2-0
P2	3-1	2-0	1-1	0-0
P3	2-0	1-1	0-0	1-0

Now, need matrix is:

	A	B	C	D
P0	1	2	0	0
P1	0	1	0	2
P2	2	2	0	0
P3	2	0	0	1

3. Safety Check:

Available = [2, 2, 2, 0]

Step 1:

Check P0 : Need (1, 2, 0, 0) ≤ Available [2,2,2,

Available + Available [P0] =

[2, 2, 2, 0] + [2, 0, 1, 1]

= [4, 2, 3, 1]

Finished [P0] = True

Sequence = [P0]

Step 2

Check P1 : Need [0,1,0,2] ≤ Available [4,2,3,1]

∵ as above decision is false, so we skip it.

Check P2 : Need [2,2,0,0] ≤ Available [4,2,3,1]

∵ Now above decision is true

Available + Allocation [P2]

Available = [5,2,4,1]

Finished [P2] = True

Sequence = [P0, P2]

Step 3:

Check P1 again : Same process repeat as above

Check P3 . Need [2,0,0,0] ≤ Available [5,2,4,1]

∵ the above decision is true

Available += Allocation [P3]

Available = [5,3,4,2]

Finished [P3] = True.

Sequence : [P0, P2, P3]

Step 4:

Now only P1 left:

Need [0, 1, 0, 2] ≤ Available [5, 3, 4, 2]

∵

The above decision is true

Available += Allocation [P1]

Available = [6, 4, 4, 2]

Finished [P1] = True

Sequence = [P0, P2, P3, P1]

Results:

Now system is purely safe

Safe sequence is:

P0 → P2 → P3 → P1