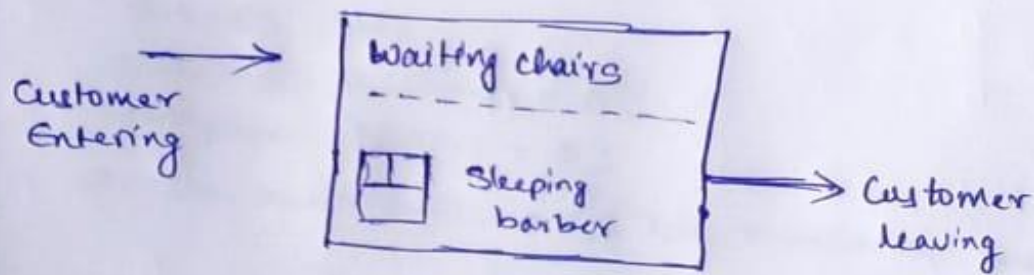


1.) Sleeping Barber:-

In computer system, the sleeping barber problem is a classic inter-process communication and synchronization between multiple OS processes.

Problem Statement:-

- Conditions:-
- (i) 1 waiting room with n chairs
 - (ii) 1 Barber room with 1 barber chair

Barber & Customer:-

- ① If there are no customers, the barber goes to sleep
- ② If Customer Enters the shop;
 - (i) If all chairs are occupied, the customer leaves the shop; otherwise he sits in one of the free chairs.
 - (ii) If barber is asleep, the customer wakes by the barber.
 - (iii) If the barber is busy & one chair is free.



Variables:-

Shared data

Semaphore Customer = 0;

Semaphore barber = 0;

access seats mutex = 1; int number of free seats = N;

Barber:-

while(true)

{

wait(customer); // waits for customer (asleep)

wait(mutex); // when even wait (1) is executed
it decrements value to 0;

i.e., mutex to protect the no. of available seats;

no. of free seats ++; // a chair gets free

Sem-post(Barber); // bring customer for haircut

Sem-post(Mutex); // release the mutex on the chair.
// barber is cutting hair

}

Customer :-

while(1)

{

Sem-wait (access seats);

if (Number of free seats > 0)

{

number of free seats --; // sitting down

Sem-post (customers); // notify the barber

Sem-post (access seats); // release the lock.

Sem-wait (barber);

} else

{

Sem-post (access seats);

}

}

Code :

```
#include <unistd.h>
#include <stdio.h>
#include <stdlib.h>
#include <pthread.h>
#include <semaphore.h>
#define MAX_CHAIRS 10
#define CUT_TIME 1
#define NUM_BARB 2
#define MAX_CUST 30
sem_t customers;
sem_t barbers;
sem_t mutex;
int numberOfFreeSeats = MAX_CHAIRS;
int seatPocket[MAX_CHAIRS];
int sitHereNext = 0;
int serveMeNext = 0;
static int count = 0;
void barberThread(void *tmp);
void customerThread(void *tmp);
void wait();
int main()
{
    pthread_t barber[NUM_BARB],customer[MAX_CUST];
    int i,status=0;
    sem_init(&customers,0,0);
    sem_init(&barbers,0,0);
    sem_init(&mutex,0,1);
    printf("Good Morning!!\n");
    for(i=0;i<NUM_BARB;i++)
    {
        status=pthread_create(&barber[i],NULL,(void )barberThread,(void)&i);
        sleep(1);
        if(status!=0)
```

```

        perror("No Barber Present... Sorry!!\n");
    }

    for(i=0;i<MAX_CUST;i++)
    {
        status=pthread_create(&customer[i],NULL,(void )customerThread,(void)&i);
        wait();
        if(status!=0)
            perror("No Customers Yet!!!\n");
    }
    for(i=0;i<MAX_CUST;i++)
        pthread_join(customer[i],NULL);
    printf("!!Barber Shop Closes!!\n");
    exit(EXIT_SUCCESS);
}

void customerThread(void *tmp)
{
    int mySeat, B;
    sem_wait(&mutex);
    count++;
    printf("Customer-%d[Id:%d] Entered Shop. ",count,pthread_self());
    if(numberOfFreeSeats > 0)
    {
        --numberOfFreeSeats;
        printf("Customer-%d Sits In Waiting Room.\n",count);
        sitHereNext = (++sitHereNext) % MAX_CHAIRS;
        mySeat = sitHereNext;
        seatPocket[mySeat] = count;
        sem_post(&mutex);
        sem_post(&barbers);
        sem_wait(&customers);
        sem_wait(&mutex);
        B = seatPocket[mySeat];
        numberOfFreeSeats++;
    }
}

```

```

        sem_post(&mutex);

    }
    else
    {
        sem_post(&mutex);
        printf("Customer-%d Finds No Seat & Leaves.\n",count);
    }
    pthread_exit(0);
}

void barberThread(void *tmp)
{
    int index = *(int *)(tmp);
    int myNext, C;
    printf("Barber-%d[Id:%d] Joins Shop. ",index,pthread_self());
    while(1)
    {
        printf("Barber-%d Gone To Sleep.\n",index);
        sem_wait(&barbers);
        sem_wait(&mutex);
        serveMeNext = (++serveMeNext) % MAX_CHAIRS;
        myNext = serveMeNext;
        C = seatPocket[myNext];
        seatPocket[myNext] = pthread_self();
        sem_post(&mutex);
        sem_post(&customers);
        printf("Barber-%d Wakes Up & Is Cutting Hair Of Customer-%d.\n",index,C);
        sleep(CUT_TIME);
        printf("Barber-%d Finishes. ",index);
    }
}

void wait()
{

```

```
int x = rand() % (250000 - 50000 + 1) + 50000;

srand(time(NULL));

usleep(x);

}
```

Output :

```
abhinav@abhinav:~/lab1604$ ./a.out
Good Morning!!
Barber-0[Id:-597797120] Joins Shop. Barber-0 Gone To Sleep.
Barber-1[Id:-606189824] Joins Shop. Barber-1 Gone To Sleep.
Customer-1[Id:-614582528] Entered Shop. Customer-1 Sits In Waiting Room.
Barber-0 Wakes Up & Is Cutting Hair Of Customer-1.
Customer-2[Id:-623085824] Entered Shop. Customer-2 Sits In Waiting Room.
Barber-1 Wakes Up & Is Cutting Hair Of Customer-2.
Customer-3[Id:-631478528] Entered Shop. Customer-3 Sits In Waiting Room.
Customer-4[Id:-639871232] Entered Shop. Customer-4 Sits In Waiting Room.
Customer-5[Id:-648263936] Entered Shop. Customer-5 Sits In Waiting Room.
Customer-6[Id:-656656640] Entered Shop. Customer-6 Sits In Waiting Room.
Customer-7[Id:-738199808] Entered Shop. Customer-7 Sits In Waiting Room.
Customer-8[Id:-746592512] Entered Shop. Customer-8 Sits In Waiting Room.
Barber-0 Finishes. End of the Day :)Barber-0 Gone To Sleep.
Barber-0 Wakes Up & Is Cutting Hair Of Customer-3.
Customer-9[Id:-754985216] Entered Shop. Customer-9 Sits In Waiting Room.
Barber-1 Finishes. End of the Day :)Barber-1 Gone To Sleep.
Barber-1 Wakes Up & Is Cutting Hair Of Customer-4.
Customer-10[Id:-763377920] Entered Shop. Customer-10 Sits In Waiting Room.
Customer-11[Id:-771770624] Entered Shop. Customer-11 Sits In Waiting Room.
Customer-12[Id:-780163328] Entered Shop. Customer-12 Sits In Waiting Room.
Customer-13[Id:-788556032] Entered Shop. Customer-13 Sits In Waiting Room.
Customer-14[Id:-796948736] Entered Shop. Customer-14 Sits In Waiting Room.
Customer-15[Id:-805341440] Entered Shop. Customer-15 Finds No Seat & Leaves.
Barber-0 Finishes. End of the Day :)Barber-0 Gone To Sleep.
Barber-0 Wakes Up & Is Cutting Hair Of Customer-5.
Customer-16[Id:-813734144] Entered Shop. Customer-16 Sits In Waiting Room.
Barber-1 Finishes. End of the Day :)Barber-1 Gone To Sleep.
Barber-1 Wakes Up & Is Cutting Hair Of Customer-6.
Customer-17[Id:-822126848] Entered Shop. Customer-17 Sits In Waiting Room.
Customer-18[Id:-830519552] Entered Shop. Customer-18 Finds No Seat & Leaves.
Customer-19[Id:-838912256] Entered Shop. Customer-19 Finds No Seat & Leaves.
Customer-20[Id:-847304960] Entered Shop. Customer-20 Finds No Seat & Leaves.
Customer-21[Id:-855697664] Entered Shop. Customer-21 Finds No Seat & Leaves.
Barber-0 Finishes. End of the Day :)Barber-0 Gone To Sleep.
Barber-0 Wakes Up & Is Cutting Hair Of Customer-7.
Customer-22[Id:-864090368] Entered Shop. Customer-22 Sits In Waiting Room.
Barber-1 Finishes. End of the Day :)Barber-1 Gone To Sleep.
Barber-1 Wakes Up & Is Cutting Hair Of Customer-8.
Customer-23[Id:-872483072] Entered Shop. Customer-23 Sits In Waiting Room.
Customer-24[Id:-880875776] Entered Shop. Customer-24 Finds No Seat & Leaves.
Customer-25[Id:-889268480] Entered Shop. Customer-25 Finds No Seat & Leaves.
Customer-26[Id:-897661184] Entered Shop. Customer-26 Finds No Seat & Leaves.
Customer-27[Id:-906053888] Entered Shop. Customer-27 Finds No Seat & Leaves.
Customer-28[Id:-914446592] Entered Shop. Customer-28 Finds No Seat & Leaves.
Barber-0 Finishes. End of the Day :)Barber-0 Gone To Sleep.
```

Barber-0 Wakes Up & Is Cutting Hair Of Customer-5.
Customer-16[Id:-813734144] Entered Shop. Customer-16 Sits In Waiting Room.
Barber-1 Finishes. End of the Day :)Barber-1 Gone To Sleep.
Barber-1 Wakes Up & Is Cutting Hair Of Customer-6.
Customer-17[Id:-822126848] Entered Shop. Customer-17 Sits In Waiting Room.
Customer-18[Id:-830519552] Entered Shop. Customer-18 Finds No Seat & Leaves.
Customer-19[Id:-838912256] Entered Shop. Customer-19 Finds No Seat & Leaves.
Customer-20[Id:-847304960] Entered Shop. Customer-20 Finds No Seat & Leaves.
Customer-21[Id:-855697664] Entered Shop. Customer-21 Finds No Seat & Leaves.
Barber-0 Finishes. End of the Day :)Barber-0 Gone To Sleep.
Barber-0 Wakes Up & Is Cutting Hair Of Customer-7.
Customer-22[Id:-864090368] Entered Shop. Customer-22 Sits In Waiting Room.
Barber-1 Finishes. End of the Day :)Barber-1 Gone To Sleep.
Barber-1 Wakes Up & Is Cutting Hair Of Customer-8.
Customer-23[Id:-872483072] Entered Shop. Customer-23 Sits In Waiting Room.
Customer-24[Id:-880875776] Entered Shop. Customer-24 Finds No Seat & Leaves.
Customer-25[Id:-889268480] Entered Shop. Customer-25 Finds No Seat & Leaves.
Customer-26[Id:-897661184] Entered Shop. Customer-26 Finds No Seat & Leaves.
Customer-27[Id:-906053888] Entered Shop. Customer-27 Finds No Seat & Leaves.
Customer-28[Id:-914446592] Entered Shop. Customer-28 Finds No Seat & Leaves.
Barber-0 Finishes. End of the Day :)Barber-0 Gone To Sleep.
Barber-0 Wakes Up & Is Cutting Hair Of Customer-9.
Barber-1 Finishes. End of the Day :)Barber-1 Gone To Sleep.
Barber-1 Wakes Up & Is Cutting Hair Of Customer-10.
Customer-29[Id:-922839296] Entered Shop. Customer-29 Sits In Waiting Room.
Customer-30[Id:-931232000] Entered Shop. Customer-30 Sits In Waiting Room.
Barber-0 Finishes. End of the Day :)Barber-0 Gone To Sleep.
Barber-0 Wakes Up & Is Cutting Hair Of Customer-11.
Barber-1 Finishes. End of the Day :)Barber-1 Gone To Sleep.
Barber-1 Wakes Up & Is Cutting Hair Of Customer-12.
Barber-0 Finishes. End of the Day :)Barber-0 Gone To Sleep.
Barber-0 Wakes Up & Is Cutting Hair Of Customer-13.
Barber-1 Finishes. End of the Day :)Barber-1 Gone To Sleep.
Barber-1 Wakes Up & Is Cutting Hair Of Customer-14.
Barber-0 Finishes. End of the Day :)Barber-0 Gone To Sleep.
Barber-0 Wakes Up & Is Cutting Hair Of Customer-16.
Barber-1 Finishes. End of the Day :)Barber-1 Gone To Sleep.
Barber-1 Wakes Up & Is Cutting Hair Of Customer-17.
Barber-0 Finishes. End of the Day :)Barber-0 Gone To Sleep.
Barber-0 Wakes Up & Is Cutting Hair Of Customer-22.
Barber-1 Finishes. End of the Day :)Barber-1 Gone To Sleep.
Barber-1 Wakes Up & Is Cutting Hair Of Customer-23.
Barber-0 Finishes. End of the Day :)Barber-0 Gone To Sleep.
Barber-0 Wakes Up & Is Cutting Hair Of Customer-29.
Barber-1 Finishes. End of the Day :)Barber-1 Gone To Sleep.
Barber-1 Wakes Up & Is Cutting Hair Of Customer-30.
!!Barber Shop Closes!!

abhinav@abhinav:~/lab1604\$