VISVESVARAYA TECHNOLOGICAL UNIVERSITY

“JnanaSangama”, Belgaum -590014, Karnataka.

LAB REPORT

on

Operating Systems

(22CS4PCOPS)

Submitted by:

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in partial fulfillment for the award of the degree of

BACHELOR OF ENGINEERING

in

COMPUTER SCIENCE AND ENGINEERING

B.M.S. COLLEGE OF ENGINEERING

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CERTIFICATE

This is to certify that the Lab work entitled "**Operating Systems**" carried out by **Bhoomi Udedh(1BM23CS066),** who is a bonafide student of **B. M. S. College of Engineering.** It is in partial fulfillment for the award of **Bachelor of Engineering in Computer Science and Engineering** of the Visvesvaraya Technological University, Belgaum during the year 2024-25. The Lab report has been approved as it satisfies the academic requirements in respect of **Operating Systems - (22CS4PCOPS)** work prescribed for the said degree.

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Course Outcomes

CO1: Apply the different concepts and functionalities of Operating System.

CO2: Analyse various Operating system strategies and techniques.

CO3: Demonstrate the different functionalities of Operating System.

CO4: Conduct practical experiments to implement the functionalities of Operating system.

GITHUB LINK:

https://github.com/bhoomiudedh/OS

Experiments

1. **Write a C program to simulate the following non-pre-emptive CPU scheduling algorithm to find turnaround time and waiting time.**

(a) FCFS

(b) SJF

```
#include<stdio.h>
   int n, i, j, pos, temp, choice, Burst_time[20], Waiting_time[20],
   Turn_around_time[20], process[20], total=0;
   float avg_Turn_around_time=0, avg_Waiting_time=0;

int FCFS()
{
   Waiting_time[0]=0;

   for(i=1;i<n;i++)
   {
      Waiting_time[i]=0;
      for(j=0;j<i;j++)
         Waiting_time[i]+=Burst_time[j];
   }

   printf("\nProcess\t\tBurst Time\t\tWaiting Time\t\tTurnaround Time");

   for(i=0;i<n;i++)
   {
      Turn_around_time[i]=Burst_time[i]+Waiting_time[i];
      avg_Waiting_time+=Waiting_time[i];
      avg_Turn_around_time+=Turn_around_time[i];

printf("\nP[%d]\t\t%d\t\t\t%d\t\t\t\t%d",i+1,Burst_time[i],Waiting_time[i],Turn_around_t
ime[i]);
   }

   avg_Waiting_time =(float)(avg_Waiting_time)/(float)i;
   avg_Turn_around_time=(float)(avg_Turn_around_time)/(float)i;
   printf("\nAverage Waiting Time:%.2f",avg_Waiting_time);
   printf("\nAverage Turnaround Time:%.2f\n",avg_Turn_around_time);

   return 0;
}
```

```
int SJF()
{
   //sorting
   for(i=0;i<n;i++)
   {
      pos=i;
      for(j=i+1;j<n;j++)
      {
         if(Burst_time[j]<Burst_time[pos])
            pos=j;
      }

      temp=Burst_time[i];
      Burst_time[i]=Burst_time[pos];
      Burst_time[pos]=temp;

      temp=process[i];
      process[i]=process[pos];
      process[pos]=temp;
   }
      Waiting_time[0]=0;


   for(i=1;i<n;i++)
   {
      Waiting_time[i]=0;

      for(j=0;j<i;j++)
         Waiting_time[i]+=Burst_time[j];

      total+=Waiting_time[i];
   }

   avg_Waiting_time=(float)total/n;
   total=0;

   printf("\nProcess\t\tBurst Time\t\tWaiting Time\t\tTurnaround Time");

   for(i=0;i<n;i++)
   {
      Turn_around_time[i]=Burst_time[i]+Waiting_time[i];
      total+=Turn_around_time[i];

printf("\nP[%d]\t\t%d\t\t\t%d\t\t\t\t%d",process[i],Burst_time[i],Waiting_time[i],Turn_ar
ound_time[i]);
```

```
    }

    avg_Turn_around_time=(float)total/n;
    printf("\n\nAverage Waiting Time=%f",avg_Waiting_time);
    printf("\nAverage Turnaround Time=%f\n",avg_Turn_around_time);
}

int main()
{
    printf("Enter the total number of processes:");
    scanf("%d",&n);

    printf("\nEnter Burst Time:\n");
    for(i=0;i<n;i++)
    {
        printf("P[%d]:",i+1);
        scanf("%d",&Burst_time[i]);
        process[i]=i+1;
    }

    while(1)
    {   printf("\n-----MAIN MENU -----\n");
        printf("1. FCFS Scheduling\n2. SJF Scheduling\n");
        printf("\nEnter your choice:");
        scanf("%d", &choice);
        switch(choice)
        {
            case 1: FCFS();
            break;

            case 2: SJF();
            break;

            default: printf("Invalid Input!!!");
        }
    }
    return 0;
}
```

Output:

a.

```
ArrivalTime.c -o FCFS_ArrivalTime } ; if ($?) { .\FCFS_ArrivalTime }
Enter the number of processes: 4
Enter the process ids:
1 2 3 4
Enter arrival time and burst time for process 1: 0 8
Enter arrival time and burst time for process 2: 1 4
Enter arrival time and burst time for process 3: 2 9
Enter arrival time and burst time for process 4: 3 5

Process Arrival Time    Burst Time    Waiting Time    Turnaround Time
1       0               8             0               8
2       1               4             7               11
3       2               9             10              19
4       3               5             18              23

Average Waiting Time: 8.75
Average Turnaround Time: 15.25
PS C:\Users\Nisarga Gondi\OneDrive\Desktop\Nisarga\lV SEM\OS 4th sem\os lab>
```

b.

```
P.c -o SJF_NP } ; if ($?) { .\SJF_NP }
Enter the number of processes:
4
Enter the burst time of process 1:
8
Enter the burst time of process 2:
4
Enter the burst time of process 3:
9
Enter the burst time of process 4:
5
BurstTime      WaitingTime     TurnAroundtime
4.00           0.00            4.00
5.00           4.00            9.00
8.00           9.00            17.00
9.00           17.00           26.00
Average waiting time:7.500000
Average turn around time:14.000000
```

2.Priority and Round Robin

```
#include<stdio.h> main()
{
int p[20],bt[20],pri[20], wt[20],tat[20],i, k, n, temp; float wtavg, tatavg;
clrscr();
printf("Enter the number of processes --- ");
  scanf("%d",&n);
for(i=0;i<n;i++)
{
  p[i] = i;
printf("Enter the Burst Time & Priority of Process %d --- ",i);
  scanf("%d%d",&bt[i], &pri[i]);
}
for(i=0;i<n;i++)
  for(k=i+1;k<n;k++)
  if(pri[i] > pri[k])
    {
      temp=p[i];
      p[i]=p[k];
      p[k]=temp;
      temp=bt[i];
      bt[i]=bt[k];
      bt[k]=temp;
      temp=pri[i]; p
      ri[i]=pri[k];
      pri[k]=temp;
}
wtavg = wt[0] = 0; tatavg = tat[0] = bt[0];
  for(i=1;i<n;i++)
  {
    wt[i] = wt[i-1] + bt[i-1];
    tat[i] = tat[i-1] + bt[i];
    wtavg = wtavg + wt[i]; tatavg = tatavg + tat[i];
}
printf("\nPROCESS\t\tPRIORITY\tBURST    TIME\tWAITING   TIME\tTURNAROUND
TIME");
for(i=0;i<n;i++)
  printf("\n%d \t\t %d \t\t %d \t\t %d \t\t %d ",p[i],pri[i],bt[i],wt[i],tat[i]);
printf("\nAverage Waiting Time is --- %f",wtavg/n);
printf("\nAverage Turnaround Time is --- %f",tatavg/n);
getch();
```

```
}
#include<stdio.h>
main()
{
int     i,j,n,bu[10],wa[10],tat[10],t,ct[10],max;
float awt=0,att=0,temp=0;
printf("Enter the no of processes -- ");
scanf("%d",&n);
for(i=0;i<n;i++)
{
printf("\nEnter Burst Time for process %d -- ", i+1);
scanf("%d",&bu[i]);
ct[i]=bu[i];
}
printf("\nEnter the size of time slice -- ");
scanf("%d",&t);
max=bu[0];
for(i=1;i<n;i++)
if(max<bu[i])
max=bu[i];

for(j=0;j<(max/t)+1;j++)
for(i=0;i<n;i++)
if(bu[i]!=0)
if(bu[i]<=t)
{
tat[i]=temp+bu[i];
temp=temp+bu[i];
bu[i]=0;
}
else
{
bu[i]=bu[i]-t;
temp=temp+t;
}
for(i=0;i<n;i++)
{
wa[i]=tat[i]-ct[i];
att+=tat[i]; awt+=wa[i];}
printf("\nThe Average Turnaround time is -- %f",att/n);
printf("\nThe Average Waiting time is -- %f ",awt/n);
printf("\n\tPROCESS\t BURST TIME \t WAITING TIME\tTURNAROUND TIME\n");
for(i=0;i<n;i++)
printf("\t%d \t %d \t\t %d \t\t %d \n",i+1,ct[i],wa[i],tat[i]); getch();
}
```

Output:

3. Rate Monotonic and Earliest Deadline first

```
#include  <stdio.h>
#include <stdlib.h>
#include <math.h>

#define MAX_PROCESS 10

int num_of_process;
int execution_time[MAX_PROCESS], period[MAX_PROCESS],
remain_time[MAX_PROCESS];

int max(int a, int b, int c) {
   if (a >= b && a >= c) return a;
   if (b >= a && b >= c) return b;
   return c;
}

void get_process_info() {
   printf("Enter total number of processes (maximum %d): ", MAX_PROCESS);
   scanf("%d", &num_of_process);
   if (num_of_process < 1) {
      printf("Invalid number of processes.\n");
      exit(0);
   }
   for (int i = 0; i < num_of_process; i++) {
      printf("\nProcess %d:\n", i + 1);
      printf("==> Execution time: ");
      scanf("%d", &execution_time[i]);
      remain_time[i] = execution_time[i];
      printf("==> Period: ");
      scanf("%d", &period[i]);
   }
}

int get_observation_time() {
   int max_period = 0;
   for (int i = 0; i < num_of_process; i++) {
      if (period[i] > max_period)
```

```
        max_period = period[i];
    }
    return max_period;
}

void print_schedule(int process_list[], int cycles) {
    printf("\nScheduling:\n\nTime: ");
    for (int i = 0; i < cycles; i++) {
        if (i < 10) printf("| 0%d ", i);
        else printf("| %d ", i);
    }
    printf("|\n");

    for (int i = 0; i < num_of_process; i++) {
        printf("P[%d]: ", i + 1);
        for (int j = 0; j < cycles; j++) {
            if (process_list[j] == i + 1) printf("|####");
            else printf("|    ");
        }
        printf("|\n");
    }
}

void rate_monotonic(int time) {
    int process_list[100] = {0}, min = 999, next_process = 0;
    float utilization = 0;
    for (int i = 0; i < num_of_process; i++) {
        utilization += (1.0 * execution_time[i]) / period[i];
    }

    int n = num_of_process;
    int m = (int)(n * (pow(2, 1.0 / n) - 1));
    if (utilization > m) {
            printf("\nGiven problem is not schedulable under the Rate Monotonic
algorithm.\n");
    }

    for (int i = 0; i < time; i++) {
        min = 1000;
        for (int j = 0; j < num_of_process; j++) {
            if (remain_time[j] > 0 && min > period[j]) {
                min = period[j];
                next_process = j;
            }
        }
```

```
        if (remain_time[next_process] > 0) {
            process_list[i] = next_process + 1;
            remain_time[next_process] -= 1;
        }
        for (int k = 0; k < num_of_process; k++) {
            if ((i + 1) % period[k] == 0) {
                remain_time[k] = execution_time[k];
            }
        }
    }
    print_schedule(process_list, time);
}

int main() {
    get_process_info();
    int observation_time = get_observation_time();
    rate_monotonic(observation_time);
    return 0;
}

#include <stdio.h>
#include <stdlib.h>
#include <stdbool.h>

#define MAX_PROCESS 10

int num_of_process;
int execution_time[MAX_PROCESS], deadline[MAX_PROCESS],
remain_time[MAX_PROCESS], remain_deadline[MAX_PROCESS];

int max(int a, int b, int c) {
    if (a >= b && a >= c) return a;
    if (b >= a && b >= c) return b;
    return c;
}

void get_process_info() {
    printf("Enter total number of processes (maximum %d): ", MAX_PROCESS);
    scanf("%d", &num_of_process);
    if (num_of_process < 1) {
        printf("Invalid number of processes.\n");
        exit(0);
    }
    for (int i = 0; i < num_of_process; i++) {
        printf("\nProcess %d:\n", i + 1);
```

```
        printf("==> Execution time: ");
        scanf("%d", &execution_time[i]);
        remain_time[i] = execution_time[i];
        printf("==> Deadline: ");
        scanf("%d", &deadline[i]);
    }
}

int get_observation_time() {
    int max_deadline = 0;
    for (int i = 0; i < num_of_process; i++) {
        if (deadline[i] > max_deadline)
            max_deadline = deadline[i];
    }
    return max_deadline;
}

void print_schedule(int process_list[], int cycles) {
    printf("\nScheduling:\n\nTime: ");
    for (int i = 0; i < cycles; i++) {
        if (i < 10) printf("| 0%d ", i);
        else printf("| %d ", i);
    }
    printf("|\n");

    for (int i = 0; i < num_of_process; i++) {
        printf("P[%d]: ", i + 1);
        for (int j = 0; j < cycles; j++) {
            if (process_list[j] == i + 1) printf("|####");
            else printf("|    ");
        }
        printf("|\n");
    }
}

void earliest_deadline_first(int time) {
    float utilization = 0;
    for (int i = 0; i < num_of_process; i++) {
        utilization += (1.0 * execution_time[i]) / deadline[i];
    }

    int process[num_of_process];
    int max_deadline, current_process = 0, min_deadline, process_list[time];
    bool is_ready[num_of_process];
    for (int i = 0; i < num_of_process; i++) {
```

```
    is_ready[i] = true;
    process[i] = i + 1;
}

max_deadline = deadline[0];
for (int i = 1; i < num_of_process; i++) {
    if (deadline[i] > max_deadline) max_deadline = deadline[i];
}

// Sorting by deadline
for (int i = 0; i < num_of_process; i++) {
    for (int j = i + 1; j < num_of_process; j++) {
        if (deadline[j] < deadline[i]) {
            int temp = execution_time[j];
            execution_time[j] = execution_time[i];
            execution_time[i] = temp;
            temp = deadline[j];
            deadline[j] = deadline[i];
            deadline[i] = temp;
            temp = process[j];
            process[j] = process[i];
            process[i] = temp;
        }
    }
}

for (int i = 0; i < num_of_process; i++) {
    remain_time[i] = execution_time[i];
    remain_deadline[i] = deadline[i];
}

for (int t = 0; t < time; t++) {
    if (current_process != -1) {
        --execution_time[current_process];
        process_list[t] = process[current_process];
    } else process_list[t] = 0;

    for (int i = 0; i < num_of_process; i++) {
        --deadline[i];
        if ((execution_time[i] == 0) && is_ready[i]) {
            deadline[i] += remain_deadline[i];
            is_ready[i] = false;
        }
        if ((deadline[i] <= remain_deadline[i]) && !is_ready[i]) {
            execution_time[i] = remain_time[i];
```

```
                is_ready[i] = true;
            }
        }

        min_deadline = max_deadline;
        current_process = -1;
        for (int i = 0; i < num_of_process; i++) {
            if ((deadline[i] <= min_deadline) && (execution_time[i] > 0)) {
                current_process = i;
                min_deadline = deadline[i];
            }
        }
    }
    print_schedule(process_list, time);
}

int main() {
    get_process_info();
    int observation_time = get_observation_time();
    earliest_deadline_first(observation_time);
    return 0;
}
```

Output:

```
1. Rate Monotonic
2. Earliest Deadline first
3. Proportional Scheduling

Enter your choice: 1
Enter total number of processes (maximum 10): 3

Process 1:
==> Execution time: 3
==> Period: 20

Process 2:
--> Execution time: 2
--> Period: 5

Process 3:
==> Execution time: 2
==> Period: 10

Scheduling:

Time: | 00 | 01 | 02 | 03 | 04 | 05 | 06 | 07 | 08 | 09 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
P[1]: |    |    |    |    |####|    |    |####|####|    |    |    |    |    |    |    |    |    |    |    |
P[2]: |####|####|    |    |    |####|####|    |    |    |####|####|    |    |    |####|####|    |    |    |
P[3]: |    |    |####|####|    |    |    |    |    |    |    |    |####|####|    |    |    |    |    |    |
```

```
1. Rate Monotonic
2. Earliest Deadline first
3. Proportional Scheduling

Enter your choice: 2
Enter total number of processes (maximum 10): 3

Process 1:
==> Execution time: 3
==> Deadline: 7

Process 2:
==> Execution time: 2
==> Deadline: 4

Process 3:
==> Execution time: 2
==> Deadline: 8

Scheduling:

Time: | 00 | 01 | 02 | 03 | 04 | 05 | 06 | 07 |
P[1]: |    |    |####|####|####|    |    |    |
P[2]: |####|####|    |    |    |    |    |####|
P[3]: |    |    |    |    |    |####|####|    |
```

4. Producer Consumer and Dining Philosophers

```
#include <stdio.h>
#include <stdlib.h>

int mutex = 1, full = 0, empty = 3, x = 0;

void producer();
void consumer();
int wait(int);
int signal(int);

int main() {
    int n;
    printf("\n1. Producer\n2. Consumer\n3. Exit");
    while(1) {
        printf("\nEnter your choice: ");
        scanf("%d", &n);
        switch(n) {
            case 1:
                if((mutex == 1) && (empty != 0))
                    producer();
```

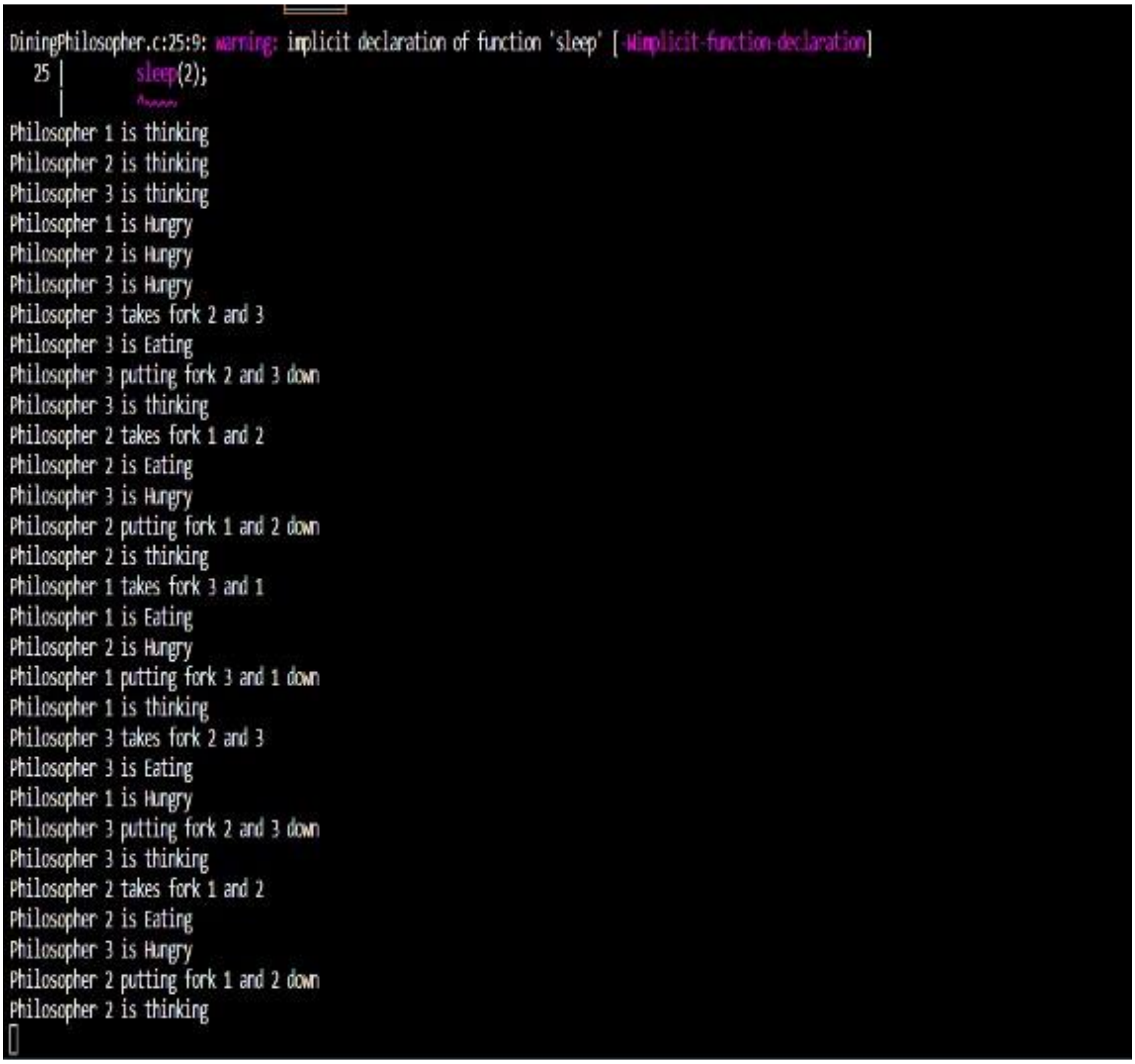
```
            else
                printf("Buffer is full!!\n");
            break;
        case 2:
            if((mutex == 1) && (full != 0))
                consumer();
            else
                printf("Buffer is empty!!\n");
            break;
        case 3:
            exit(0);
            break;
        }
    }
    return 0;
}

int wait(int s) {
    return (--s);
}

int signal(int s) {
    return (++s);
}

void producer() {
    mutex = wait(mutex);
    full = signal(full);
    empty = wait(empty);
    x++;
    printf("\nProducer produces the item %d\n", x);
    mutex = signal(mutex);
}

void consumer() {
    mutex = wait(mutex);
    full = wait(full);
    empty = signal(empty);
    printf("\nConsumer consumes item %d\n", x);
    x--;
    mutex = signal(mutex);
}

#include <stdio.h>
#include <pthread.h>
```

```
#include <semaphore.h>
#include <unistd.h>  // For usleep

#define N 5
#define THINKING 2
#define HUNGRY 1
#define EATING 0
#define LEFT (i + 4) % N
#define RIGHT (i + 1) % N

int state[N];
int phil[N] = {0, 1, 2, 3, 4};
sem_t mutex;
sem_t S[N];

void test(int i) {
    if (state[i] == HUNGRY && state[LEFT] != EATING && state[RIGHT] != EATING) {
        state[i] = EATING;
        usleep(2000000);  // Simulate eating time (2 seconds)
        printf("Philosopher %d takes fork %d and %d\n", i + 1, LEFT + 1, i + 1);
        printf("Philosopher %d is Eating\n", i + 1);
        sem_post(&S[i]);
    }
}

void take_fork(int i) {
    sem_wait(&mutex);
    state[i] = HUNGRY;
    printf("Philosopher %d is Hungry\n", i + 1);
    test(i);
    sem_post(&mutex);
    sem_wait(&S[i]);
    usleep(1000000);  // Simulate thinking time (1 second)
}

void put_fork(int i) {
    sem_wait(&mutex);
    state[i] = THINKING;
    printf("Philosopher %d putting fork %d and %d down\n", i + 1, LEFT + 1, i + 1);
    printf("Philosopher %d is thinking\n", i + 1);
    test(LEFT);
    test(RIGHT);
    sem_post(&mutex);
}
```

```
void* philosopher(void* num) {
    while (1) {
        int* i = num;
        usleep(1000000);  // Simulate thinking before trying to eat
        take_fork(*i);
        usleep(1000000);  // Simulate time spent eating
        put_fork(*i);
    }
}

int main() {
    int i;
    pthread_t thread_id[N];
    sem_init(&mutex, 0, 1);
    for (i = 0; i < N; i++) {
        sem_init(&S[i], 0, 0);
    }

    for (i = 0; i < N; i++) {
        pthread_create(&thread_id[i], NULL, philosopher, &phil[i]);
        printf("Philosopher %d is thinking\n", i + 1);
    }

    for (i = 0; i < N; i++) {
        pthread_join(thread_id[i], NULL);
    }

    return 0;
}
```

Output:

```
cerConcumer.c -o ProducerConcumer } ; if ($?) { .\ProducerConcumer }
Produced: 0
Produced: 1
Produced: 2
Produced: 3
Produced: 4
Produced: 5
Produced: 6
Produced: 7
Produced: 8
Produced: 9
Consumed: 0
Consumed: 1
Consumed: 2
Consumed: 3
Consumed: 4
Consumed: 5
Consumed: 6
Consumed: 7
Consumed: 8
Consumed: 9
```



```
DiningPhilosopher.c:25:9: warning: implicit declaration of function 'sleep' [-Wimplicit-function-declaration]
   25 |         sleep(2);
      |         ^~~~~
Philosopher 1 is thinking
Philosopher 2 is thinking
Philosopher 3 is thinking
Philosopher 1 is Hungry
Philosopher 2 is Hungry
Philosopher 3 is Hungry
Philosopher 3 takes fork 2 and 3
Philosopher 3 is Eating
Philosopher 3 putting fork 2 and 3 down
Philosopher 3 is thinking
Philosopher 2 takes fork 1 and 2
Philosopher 2 is Eating
Philosopher 3 is Hungry
Philosopher 2 putting fork 1 and 2 down
Philosopher 2 is thinking
Philosopher 1 takes fork 3 and 1
Philosopher 1 is Eating
Philosopher 2 is Hungry
Philosopher 1 putting fork 3 and 1 down
Philosopher 1 is thinking
Philosopher 3 takes fork 2 and 3
Philosopher 3 is Eating
Philosopher 1 is Hungry
Philosopher 3 putting fork 2 and 3 down
Philosopher 3 is thinking
Philosopher 2 takes fork 1 and 2
Philosopher 2 is Eating
Philosopher 3 is Hungry
Philosopher 2 putting fork 1 and 2 down
Philosopher 2 is thinking
```

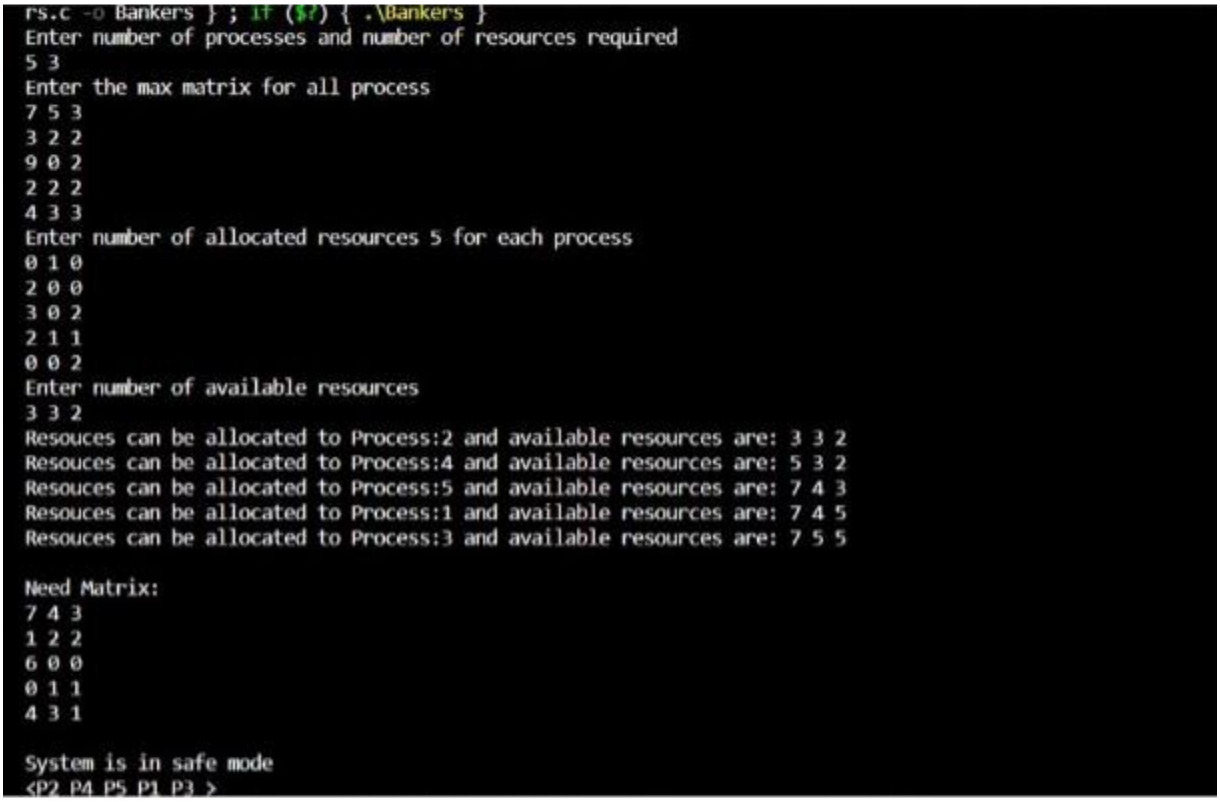
5. Bankers Algorithm

```
#include <stdio.h>
int main() {
    int n, m, i, j, k;
    printf("Enter the number of processes: ");
    scanf("%d", &n);
    printf("Enter the number of resources: ");
    scanf("%d", &m);
    int allocation[n][m];
    int max[n][m];
    int available[m];
    int need[n][m];
    int finish[n], safeSeq[n], index = 0;
    printf("Enter the Allocation Matrix:\n");
    for (i = 0; i < n; i++)
    {
        for (j = 0; j < m; j++)
        {
```

```
        scanf("%d", &allocation[i][j]);
    }
}
printf("Enter the MAX Matrix:\n");
for (i = 0; i < n; i++)
{
    for (j = 0; j < m; j++)
    {
        scanf("%d", &max[i][j]);
    }
}
printf("Enter the Available Resources:\n");
for (i = 0; i < m; i++)
{
    scanf("%d", &available[i]);
}
for (i = 0; i < n; i++)
{
    for (j = 0; j < m; j++)
    {
        need[i][j] = max[i][j] - allocation[i][j];
    }
}
for (i = 0; i < n; i++)
{
    finish[i] = 0;
}
for (k = 0; k < n; k++)
{
    for (i = 0; i < n; i++)
    {
        if (finish[i] == 0)
        {
            int flag = 1;
            for (j = 0; j < m; j++)
            {
                if (need[i][j] > available[j])
                {
                    flag = 0;
                    break;
                }
            }
            if (flag == 1)
            {
                safeSeq[index++] = i;
```

```c
                for (j = 0; j < m; j++)
                {
                    available[j] += allocation[i][j];
                }
                finish[i] = 1;
            }
        }
    }
}
int allFinished = 1;
for (i = 0; i < n; i++)
{
    if (finish[i] == 0)
    {
        allFinished = 0;
        break;
    }
}
if (allFinished)
{
    printf("Following is the SAFE Sequence:\n");
    for (i = 0; i < n - 1; i++)
    {
        printf("P%d -> ", safeSeq[i]);
    }
    printf("P%d\n", safeSeq[n - 1]);
}
else
{
    printf("The system is NOT in a safe state.\n");
}

return 0;
}
```

Output:



```
rs.c -o Bankers } ; if ($?) { .\Bankers }
Enter number of processes and number of resources required
5 3
Enter the max matrix for all process
7 5 3
3 2 2
9 0 2
2 2 2
4 3 3
Enter number of allocated resources 5 for each process
0 1 0
2 0 0
3 0 2
2 1 1
0 0 2
Enter number of available resources
3 3 2
Resouces can be allocated to Process:2 and available resources are: 3 3 2
Resouces can be allocated to Process:4 and available resources are: 5 3 2
Resouces can be allocated to Process:5 and available resources are: 7 4 3
Resouces can be allocated to Process:1 and available resources are: 7 4 5
Resouces can be allocated to Process:3 and available resources are: 7 5 5

Need Matrix:
7 4 3
1 2 2
6 0 0
0 1 1
4 3 1

System is in safe mode
<P2 P4 P5 P1 P3 >
```

6. Deadlock Detection

```
#include <stdio.h>
static int mark[20];
int i, j, np, nr;
int main()
{
    int alloc[10][10], request[10][10], avail[10], r[10], w[10];
    printf("\nEnter the number of processes: ");
    scanf("%d", &np);
    printf("\nEnter the number of resources: ");
    scanf("%d", &nr);
    for (i = 0; i < nr; i++)
    {
        printf("Total amount of Resource R%d: ", i + 1);
        scanf("%d", &r[i]);
    }
    printf("\nEnter the Request Matrix:\n");
    for (i = 0; i < np; i++)
    {
        for (j = 0; j < nr; j++)
        {
```

```
        scanf("%d", &request[i][j]);
    }
}
printf("\nEnter the Allocation Matrix:\n");
for (i = 0; i < np; i++)
{
    for (j = 0; j < nr; j++)
    {
        scanf("%d", &alloc[i][j]);
    }
}
for (j = 0; j < nr; j++)
{
    avail[j] = r[j];
    for (i = 0; i < np; i++)
    {
        avail[j] -= alloc[i][j];
    }
}
for (i = 0; i < np; i++)
{
    int count = 0;
    for (j = 0; j < nr; j++)
    {
        if (alloc[i][j] == 0)
            count++;
        else
            break;
    }
    if (count == nr)
        mark[i] = 1;
}
for (j = 0; j < nr; j++)
    w[j] = avail[j];
for (i = 0; i < np; i++)
{
    int canBeProcessed = 0;
    if (mark[i] != 1)
    {
        for (j = 0; j < nr; j++)
        {
            if (request[i][j] <= w[j])
                canBeProcessed = 1;
            else {
                canBeProcessed = 0;
```

```
                break;
            }
        }
        if (canBeProcessed)
        {
            mark[i] = 1;
            for (j = 0; j < nr; j++)
                w[j] += alloc[i][j];
        }
    }
}
int deadlock = 0;
for (i = 0; i < np; i++)
{
    if (mark[i] != 1)
    {
        deadlock = 1;
        break;
    }
}

if (deadlock)
    printf("\nDeadlock detected.\n");
else
    printf("\nNo Deadlock possible.\n");

return 0;
}
```

Output:

```
Enter the number of processes: 3

Enter the number of resources: 2
Total amount of Resource R1: 12
Total amount of Resource R2: 16

Enter the Request Matrix:
1
2
7
3
9
5

Enter the Allocation Matrix:
1
5
2
7
3
8

Deadlock detected.
```

7. First fit, Best fit, Worst fit

```
 #include <stdio.h>
#define MAX 25

void firstFit(int b[], int nb, int f[], int nf);
void worstFit(int b[], int nb, int f[], int nf);
void bestFit(int b[], int nb, int f[], int nf);

int main() {
    int b[MAX], f[MAX], nb, nf;
    printf("Memory Management Schemes\n");
    printf("\nEnter the number of blocks: ");
    scanf("%d", &nb);
    printf("Enter the number of files: ");
    scanf("%d", &nf);
    printf("\nEnter the size of the blocks:\n");
    for (int i = 0; i < nb; i++)
    {
```

```
        printf("Block %d: ", i + 1);
        scanf("%d", &b[i]);
    }

    printf("\nEnter the size of the files:\n");
    for (int i = 0; i < nf; i++)
    {
        printf("File %d: ", i + 1);
        scanf("%d", &f[i]);
    }

    printf("\nMemory Management Scheme - First Fit");
    firstFit(b, nb, f, nf);

    printf("\n\nMemory Management Scheme - Worst Fit");
    worstFit(b, nb, f, nf);

    printf("\n\nMemory Management Scheme - Best Fit");
    bestFit(b, nb, f, nf);

    return 0;
}

void firstFit(int b[], int nb, int f[], int nf)
{
    int bf[MAX] = {0}, ff[MAX] = {0}, frag[MAX];

    for (int i = 0; i < nf; i++)
    {
        ff[i] = -1;
        for (int j = 0; j < nb; j++)
        {
            if (!bf[j] && b[j] >= f[i])
            {
                ff[i] = j;
                bf[j] = 1;
                frag[i] = b[j] - f[i];
                break;
            }
        }
    }

    printf("\nFile_no:\tFile_size:\tBlock_no:\tBlock_size:\tFragment");
    for (int i = 0; i < nf; i++)
    {
```

```
        if (ff[i] != -1)
            printf("\n%d\t\t%d\t\t%d\t\t%d\t\t%d", i + 1, f[i], ff[i] + 1, b[ff[i]], frag[i]);
        else
            printf("\n%d\t\t%d\t\tNot Allocated", i + 1, f[i]);
    }
}

void worstFit(int b[], int nb, int f[], int nf)
{
    int bf[MAX] = {0}, ff[MAX] = {0}, frag[MAX];

    for (int i = 0; i < nf; i++)
    {
        int worstIdx = -1;
        for (int j = 0; j < nb; j++)
        {
            if (!bf[j] && b[j] >= f[i])
            {
                if (worstIdx == -1 || b[j] - f[i] > b[worstIdx] - f[i])
                {
                    worstIdx = j;
                }
            }
        }
        ff[i] = worstIdx;
        if (worstIdx != -1)
        {
            bf[worstIdx] = 1;
            frag[i] = b[worstIdx] - f[i];
        }
    }

    printf("\nFile_no:\tFile_size:\tBlock_no:\tBlock_size:\tFragment");
    for (int i = 0; i < nf; i++)
    {
        if (ff[i] != -1)
            printf("\n%d\t\t%d\t\t%d\t\t%d\t\t%d", i + 1, f[i], ff[i] + 1, b[ff[i]], frag[i]);
        else
            printf("\n%d\t\t%d\t\tNot Allocated", i + 1, f[i]);
    }
}

void bestFit(int b[], int nb, int f[], int nf)
{
    int bf[MAX] = {0}, ff[MAX] = {0}, frag[MAX];
```

```
    for (int i = 0; i < nf; i++)
    {
        int bestIdx = -1;
        for (int j = 0; j < nb; j++)
        {
            if (!bf[j] && b[j] >= f[i])
            {
                if (bestIdx == -1 || b[j] - f[i] < b[bestIdx] - f[i])
                {
                    bestIdx = j;
                }
            }
        }
        ff[i] = bestIdx;
        if (bestIdx != -1)
        {
            bf[bestIdx] = 1;
            frag[i] = b[bestIdx] - f[i];
        }
    }

    printf("\nFile_no:\tFile_size:\tBlock_no:\tBlock_size:\tFragment");
    for (int i = 0; i < nf; i++)
    {
        if (ff[i] != -1)
            printf("\n%d\t\t%d\t\t%d\t\t%d\t\t%d", i + 1, f[i], ff[i] + 1, b[ff[i]], frag[i]);
        else
            printf("\n%d\t\t%d\t\tNot Allocated", i + 1, f[i]);
    }
}
```

Output:

```
Memory Management Schemes

Enter the number of blocks: 4
Enter the number of files: 2

Enter the size of the blocks:
Block 1: 34
Block 2: 12
Block 3: 22
Block 4: 25

Enter the size of the files:
File 1: 11
File 2: 15

Memory Management Scheme - First Fit
File_no:    File_size:  Block_no:   Block_size: Fragment
1       11      1       34      23
2       15      3       22      7

Memory Management Scheme - Worst Fit
File_no:    File_size:  Block_no:   Block_size: Fragment
1       11      1       34      23
2       15      4       25      10

Memory Management Scheme - Best Fit
File_no:    File_size:  Block_no:   Block_size: Fragment
1       11      2       12      1
2       15      3       22      7
```

8. LRU-Optimal-FIFO

```
#include <stdio.h>

int n, f, i, j, k;
int in[100];
int p[50];
int hit = 0;
int pgfaultcnt = 0;

void getData() {
    printf("\nEnter length of page reference sequence: ");
    scanf("%d", &n);
```

```
    printf("\nEnter the page reference sequence: ");
    for(i = 0; i < n; i++)
        scanf("%d", &in[i]);
    printf("\nEnter number of frames: ");
    scanf("%d", &f);
}

void initialize() {
    pgfaultcnt = 0;
    for(i = 0; i < f; i++)
        p[i] = 9999;
}

int isHit(int data) {
    hit = 0;
    for(j = 0; j < f; j++) {
        if(p[j] == data) {
            hit = 1;
            break;
        }
    }
    return hit;
}

void dispPages() {
    for (k = 0; k < f; k++) {
        if(p[k] != 9999)
            printf(" %d", p[k]);
    }
    printf("\n");
}

void dispPgFaultCnt() {
    printf("\nTotal number of page faults: %d\n", pgfaultcnt);
}

void fifo() {
    initialize();
    int index = 0;
    for(i = 0; i < n; i++) {
        printf("For %d :", in[i]);
        if(isHit(in[i]) == 0) {
            p[index] = in[i];
            index = (index + 1) % f;
            pgfaultcnt++;
```

```
            printf(" Page Fault ->");
            dispPages();
        } else {
            printf(" No page fault\n");
        }
    }
    dispPgFaultCnt();
}

void optimal() {
    initialize();
    int near[50];
    for(i = 0; i < n; i++) {
        printf("For %d :", in[i]);
        if(isHit(in[i]) == 0) {
            for(j = 0; j < f; j++) {
                int pg = p[j];
                int found = 0;
                for(k = i + 1; k < n; k++) {
                    if(pg == in[k]) {
                        near[j] = k;
                        found = 1;
                        break;
                    }
                }
                if(!found)
                    near[j] = 9999;
            }
            int max = -1, repindex = -1;
            for(j = 0; j < f; j++) {
                if(near[j] > max) {
                    max = near[j];
                    repindex = j;
                }
            }
            p[repindex] = in[i];
            pgfaultcnt++;
            printf(" Page Fault ->");
            dispPages();
        } else {
            printf(" No page fault\n");
        }
    }
    dispPgFaultCnt();
}
```

```
void lru() {
    initialize();
    int least[50];
    for(i = 0; i < n; i++) {
        printf("For %d :", in[i]);
        if(isHit(in[i]) == 0) {
            for(j = 0; j < f; j++) {
                int pg = p[j];
                int found = 0;
                for(k = i - 1; k >= 0; k--) {
                    if(pg == in[k]) {
                        least[j] = k;
                        found = 1;
                        break;
                    }
                }
                if(!found)
                    least[j] = -1;
            }
            int min = 9999, repindex = -1;
            for(j = 0; j < f; j++) {
                if(least[j] < min) {
                    min = least[j];
                    repindex = j;
                }
            }
            p[repindex] = in[i];
            pgfaultcnt++;
            printf(" Page Fault ->");
            dispPages();
        } else {
            printf(" No page fault\n");
        }
    }
    dispPgFaultCnt();
}

int main() {
    int choice;
    while(1) {
        printf("\nPage Replacement Algorithms\n");
        printf("1. Enter data\n");
        printf("2. FIFO\n");
        printf("3. Optimal\n");
```

```
        printf("4. LRU\n");
        printf("5. Exit\n");
        printf("Enter your choice: ");
        scanf("%d", &choice);
        switch(choice) {
            case 1: getData(); break;
            case 2: fifo(); break;
            case 3: optimal(); break;
            case 4: lru(); break;
            case 5: return 0;
            default: printf("Invalid choice. Try again.\n");
        }
    }
}
```

Output:

```
Page Replacement Algorithms
1. Enter data
2. FIFO
3. Optimal
4. LRU
5. Exit
Enter your choice: 1

Enter length of page reference sequence: 4

Enter the page reference sequence: 3 6 1 8

Enter number of frames: 2

Page Replacement Algorithms
1. Enter data
2. FIFO
3. Optimal
4. LRU
5. Exit
Enter your choice: 2
For 3 : Page Fault -> 3
For 6 : Page Fault -> 3 6
For 1 : Page Fault -> 1 6
For 8 : Page Fault -> 1 8

Total number of page faults: 4
```

```
Page Replacement Algorithms
1. Enter data
2. FIFO
3. Optimal
4. LRU
5. Exit
Enter your choice: 3
For 3 : Page Fault -> 3
For 6 : Page Fault -> 6
For 1 : Page Fault -> 1
For 8 : Page Fault -> 8

Total number of page faults: 4

Page Replacement Algorithms
1. Enter data
2. FIFO
3. Optimal
4. LRU
5. Exit
Enter your choice: 4
For 3 : Page Fault -> 3
For 6 : Page Fault -> 3 6
For 1 : Page Fault -> 1 6
For 8 : Page Fault -> 1 8

Total number of page faults: 4
```