VISVESVARAYA TECHNOLOGICAL UNIVERSITY
"JnanaSangama", Belgaum -590014, Karnataka.

LAB REPORT
on

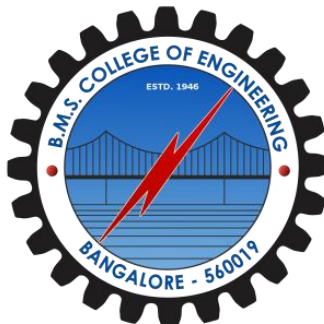## Operating Systems
(23CS4PCOPS)

Submitted by:

Arin D'souza (1BM22CS052)

in partial fulfillment for the award of the degree of
BACHELOR OF ENGINEERING
in
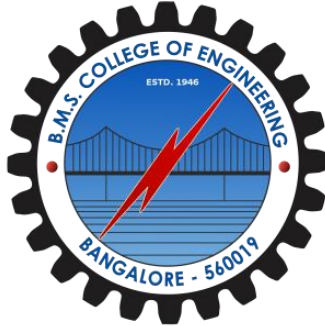**COMPUTER SCIENCE AND ENGINEERING**

B.M.S. COLLEGE OF ENGINEERING
(Autonomous Institution under VTU)
BENGALURU-560019
June 2024 - August 2024

B. M. S. College of Engineering,
Bull Temple Road, Bangalore 560019
(Affiliated To Visvesvaraya Technological University, Belgaum)
Department of Computer Science and Engineering

CERTIFICATE

This is to certify that the Lab work entitled "**Operating Systems**" carried out by **Arin D'souza (1BM22CS052),** who is 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 2022-23. The Lab report has been approved as it satisfies the academic requirements in respect of **Operating Systems - (23CS4PCOPS)** 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.

LAB - 1

Question 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

CODE:

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

void FCFS() {
    int total_waiting_time = 0, total_turnaround_time = 0;
    int current_time = 0;


    for (i = 0; i < n - 1; i++) {
        for (j = i + 1; j < n; j++) {
            if (Arrival_time[i] > Arrival_time[j]) {
                temp = Arrival_time[i];
                Arrival_time[i] = Arrival_time[j];
                Arrival_time[j] = temp;

                temp = Burst_time[i];
                Burst_time[i] = Burst_time[j];
                Burst_time[j] = temp;

                temp = process[i];
                process[i] = process[j];
                process[j] = temp;
            }
        }
    }

    Waiting_time[0] = 0;
    current_time = Arrival_time[0] + Burst_time[0];

    for (i = 1; i < n; i++) {
        if (current_time < Arrival_time[i]) {
            current_time = Arrival_time[i];
        }
        Waiting_time[i] = current_time - Arrival_time[i];
        current_time += Burst_time[i];
        total_waiting_time += Waiting_time[i];
    }

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

```c
    for (i = 0; i < n; i++) {
        Turn_around_time[i] = Burst_time[i] + Waiting_time[i];
        total_turnaround_time += Turn_around_time[i];
        printf("\nP[%d]\t\t%d\t\t%d\t\t%d\t\t%d", process[i], Arrival_time[i], Burst_time[i], Waiting_time[i], Turn_around_time[i]);
    }

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

void SJF() {
    int total_waiting_time = 0, total_turnaround_time = 0;
    int completed = 0, current_time = 0, min_index;
    int is_completed[20] = {0};

    while (completed != n) {
        int min_burst_time = 9999;
        min_index = -1;

        for (i = 0; i < n; i++) {
            if (Arrival_time[i] <= current_time && is_completed[i] == 0) {
                if (Burst_time[i] < min_burst_time) {
                    min_burst_time = Burst_time[i];
                    min_index = i;
                }
                if (Burst_time[i] == min_burst_time) {
                    if (Arrival_time[i] < Arrival_time[min_index]) {
                        min_burst_time = Burst_time[i];
                        min_index = i;
                    }
                }
            }
        }

        if (min_index != -1) {
            Waiting_time[min_index] = current_time - Arrival_time[min_index];
            current_time += Burst_time[min_index];
            Turn_around_time[min_index] = current_time - Arrival_time[min_index];
            total_waiting_time += Waiting_time[min_index];
            total_turnaround_time += Turn_around_time[min_index];
            is_completed[min_index] = 1;
            completed++;
        } else {
            current_time++;
        }
    }

    printf("\nProcess\t\tArrival Time\tBurst Time\tWaiting Time\tTurnaround Time");
    for (i = 0; i < n; i++) {
```

```c
        printf("\nP[%d]\t\t%d\t\t%d\t\t%d\t\t%d", process[i], Arrival_time[i], Burst_time[i], Waiting_time[i],
Turn_around_time[i]);
    }

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

int main() {
    printf("Enter the total number of processes: ");
    scanf("%d", &n);
    printf("\nEnter Arrival Time and Burst Time:\n");
    for (i = 0; i < n; i++) {
        printf("P[%d] Arrival Time: ", i + 1);
        scanf("%d", &Arrival_time[i]);
        printf("P[%d] Burst Time: ", 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!!!\n");
        }
    }
    return 0;
}
```

OUTPUTS:

a.

```
Enter the total number of processes: 5

Enter Arrival Time and Burst Time:
P[1] Arrival Time: 0
P[1] Burst Time: 10
P[2] Arrival Time: 0
P[2] Burst Time: 1
P[3] Arrival Time: 3
P[3] Burst Time: 2
P[4] Arrival Time: 5
P[4] Burst Time: 1
P[5] Arrival Time: 10
P[5] Burst Time: 5

-----MAIN MENU-----
1. FCFS Scheduling
2. SJF Scheduling

Enter your choice: 1

Process      Arrival Time    Burst Time  Waiting Time    Turnaround Time
P[1]         0        10     0       10
P[2]         0        1      10      11
P[3]         3        2      8       10
P[4]         5        1      8       9
P[5]         10       5      4       9
Average Waiting Time: 6.00
Average Turnaround Time: 9.80
```

b.

```
Enter the total number of processes: 4

Enter Arrival Time and Burst Time:
P[1] Arrival Time: 0
P[1] Burst Time: 3
P[2] Arrival Time: 1
P[2] Burst Time: 6
P[3] Arrival Time: 4
P[3] Burst Time: 4
P[4] Arrival Time: 6
P[4] Burst Time: 2


-----MAIN MENU-----
1. FCFS Scheduling
2. SJF Scheduling

Enter your choice: 2

Process      Arrival Time    Burst Time  Waiting Time    Turnaround Time
P[1]         0       3       0       3
P[2]         1       6       2       8
P[3]         4       4       7       11
P[4]         6       2       3       5


Average Waiting Time = 3.00
Average Turnaround Time = 6.75
```

LAB - 2

Question:
Write a C program to simulate the following CPU scheduling algorithm to find turnaround time and waiting time.

(a) **Priority (pre-emptive & Non-pre-emptive)**

(b) **Round Robin (Experiment with different quantum sizes for RR algorithm)**

CODE:

(a) <u>**Priority (Non-pre-emptive)**</u>

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

struct process {
    int process_id;
    int burst_time;
    int priority;
    int waiting_time;
    int turnaround_time;
};

void find_average_time(struct process[], int);

void priority_scheduling(struct process[], int);

int main()
{
    int n, i;
    struct process proc[10];

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

for(i = 0; i< n; i++)
    {
        printf("\nEnter the process ID: ");
        scanf("%d", &proc[i].process_id);

        printf("Enter the burst time: ");
        scanf("%d", &proc[i].burst_time);

        printf("Enter the priority: ");
        scanf("%d", &proc[i].priority);
    }

    priority_scheduling(proc, n);
    return 0;
}
```

```c
void find_waiting_time(struct process proc[], int n, int wt[])
{
    int i;
    wt[0] = 0;

    for(i = 1; i< n; i++)
    {
        wt[i] = proc[i - 1].burst_time + wt[i - 1];
    }
}

void find_turnaround_time(struct process proc[], int n, int wt[], int tat[])
{
    int i;
    for(i = 0; i< n; i++)
    {
        tat[i] = proc[i].burst_time + wt[i];
    }
}

void find_average_time(struct process proc[], int n)
{
    int wt[10], tat[10], total_wt = 0, total_tat = 0, i;

    find_waiting_time(proc, n, wt);
    find_turnaround_time(proc, n, wt, tat);

    printf("\nProcess ID\tBurst Time\tPriority\tWaiting Time\tTurnaround Time");

    for(i = 0; i< n; i++)
    {
        total_wt = total_wt + wt[i];
        total_tat = total_tat + tat[i];
        printf("\n%d\t\t%d\t\t%d\t\t%d\t\t%d", proc[i].process_id, proc[i].burst_time, proc[i].priority, wt[i],
                tat[i]);
    }
    printf("\n\nAverage Waiting Time = %f", (float)total_wt/n);
    printf("\nAverage Turnaround Time = %f\n", (float)total_tat/n);
}
void priority_scheduling(struct process proc[], int n)
{
    int i, j, pos;
    struct process temp;
    for(i = 0; i< n; i++)
    {
        pos = i;
        for(j = i + 1; j < n; j++)
        {
            if(proc[j].priority< proc[pos].priority)
            pos = j;
        }
        temp = proc[i];
```

```
        proc[i] = proc[pos];
        proc[pos] = temp;
    }
    find_average_time(proc, n);
}
```
OUTPUT:

```
Enter the number of processes: 5

Enter the process ID: 1
Enter the burst time: 4
Enter the priority: 2

Enter the process ID: 2
Enter the burst time: 3
Enter the priority: 3

Enter the process ID: 3
Enter the burst time: 1
Enter the priority: 4

Enter the process ID: 4
Enter the burst time: 5
Enter the priority: 5

Enter the process ID: 5
Enter the burst time: 2
Enter the priority: 5

Process ID       Burst Time       Priority         Waiting Time     Turnaround Time
1                4                2                0                4
2                3                3                4                7
3                1                4                7                8
4                5                5                8                13
5                2                5                13               15

Average Waiting Time = 6.400000
Average Turnaround Time = 9.400000
```

Priority (Pre-emptive):
CODE:

#include<stdio.h>

#include<stdlib.h>

struct process {

    int process_id;

    int burst_time;

    int priority;

    int arrival_time;

    int remaining_time;

    int waiting_time;

    int turnaround_time;

    int is_completed;

};

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```c
void find_average_time(struct process[], int);
void priority_scheduling(struct process[], int);

int main() {
    int n, i;
    struct process proc[10];

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

    for (i = 0; i < n; i++) {
        printf("\nEnter the process ID: ");
        scanf("%d", &proc[i].process_id);

        printf("Enter the burst time: ");
        scanf("%d", &proc[i].burst_time);

        printf("Enter the arrival time: ");
        scanf("%d", &proc[i].arrival_time);

        printf("Enter the priority: ");
        scanf("%d", &proc[i].priority);

        proc[i].remaining_time = proc[i].burst_time;
        proc[i].is_completed = 0;
    }

    priority_scheduling(proc, n);
    return 0;
}

void find_waiting_time(struct process proc[], int n) {
    int time = 0, completed = 0, min_priority, shortest = 0;
    while (completed != n) {
        min_priority = 10000;
        for (int i = 0; i < n; i++) {
            if ((proc[i].arrival_time <= time) && (!proc[i].is_completed) && (proc[i].priority < min_priority)) {
                min_priority = proc[i].priority;
                shortest = i;
            }
```

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```c
        }
        proc[shortest].remaining_time--;
        time++;
        if (proc[shortest].remaining_time == 0) {
            proc[shortest].waiting_time = time - proc[shortest].arrival_time - proc[shortest].burst_time;
            proc[shortest].turnaround_time = time - proc[shortest].arrival_time;
            proc[shortest].is_completed = 1;
            completed++;
        }
    }
}


void find_turnaround_time(struct process proc[], int n) {
    // Turnaround time is calculated during the find_waiting_time function
}


void find_average_time(struct process proc[], int n) {
    int total_wt = 0, total_tat = 0;
    find_waiting_time(proc, n);
    find_turnaround_time(proc, n);

    printf("\nProcess ID\tBurst Time\tArrival Time\tPriority\tWaiting Time\tTurnaround Time");

    for (int i = 0; i < n; i++) {
        total_wt += proc[i].waiting_time;
        total_tat += proc[i].turnaround_time;
        printf("\n%d\t\t%d\t\t%d\t\t%d\t\t%d\t\t%d", proc[i].process_id, proc[i].burst_time,
proc[i].arrival_time, proc[i].priority, proc[i].waiting_time, proc[i].turnaround_time);
    }
    printf("\n\nAverage Waiting Time = %f", (float)total_wt / n);
    printf("\nAverage Turnaround Time = %f\n", (float)total_tat / n);
}

void priority_scheduling(struct process proc[], int n) {
    find_average_time(proc, n);
}
```

OUTPUT:

```
Enter the number of processes: 5
Enter the process ID: 5
Enter the burst time: 2
Enter the arrival time: 4
Enter the priority: 5
Enter the process ID: 1
Enter the burst time: 4
Enter the arrival time: 0
Enter the priority: 2
Enter the process ID: 2
Enter the burst time: 3
Enter the arrival time: 1
Enter the priority: 3
Enter the process ID: 3
Enter the burst time: 1
Enter the arrival time: 2
Enter the priority: 4
Enter the process ID: 4
Enter the burst time: 5
Enter the arrival time: 3
Enter the priority: 5

Process ID       Burst Time        Arrival Time      Priority        Waiting Time      Turnaround Time
5                2                 4                 5               4                 6
1                4                 0                 2               0                 4
2                3                 1                 3               3                 6
3                1                 2                 4               5                 6
4                5                 3                 5               7                 12

Average Waiting Time = 3.800000
Average Turnaround Time = 6.800000
```

(b)   Round Robin (Non-pre-emptive)

```c
#include <stdio.h>
#include <stdbool.h>

void findTurnaroundTime(int processes[], int n, int bt[], int wt[], int tat[]) {
    for (int i = 0; i < n; i++) {
        tat[i] = bt[i] + wt[i];
    }
}

void findWaitingTime(int processes[], int n, int bt[], int wt[], int quantum) {
    int rem_bt[n];
    for (int i = 0; i < n; i++) {
        rem_bt[i] = bt[i];
    }
    int t = 0;

    while (1) {
        bool done = true;
        for (int i = 0; i < n; i++) {
            if (rem_bt[i] > 0) {
```

```c
            done = false;
            if (rem_bt[i] > quantum) {
                t += quantum;
                rem_bt[i] -= quantum;
            } else {
                t += rem_bt[i];
                wt[i] = t - bt[i];
                rem_bt[i] = 0;
            }
        }
    }
    if (done == true)
        break;
    }
}

void findAvgTime(int processes[], int n, int bt[], int quantum) {
    int wt[n], tat[n], total_wt = 0, total_tat = 0;

    findWaitingTime(processes, n, bt, wt, quantum);
    findTurnaroundTime(processes, n, bt, wt, tat);

    printf("\nProcess ID\tBurst Time\tWaiting Time\tTurnaround Time\n");

    for (int i = 0; i < n; i++) {
        total_wt += wt[i];
        total_tat += tat[i];
        printf("%d\t\t%d\t\t%d\t\t%d\n", processes[i], bt[i], wt[i], tat[i]);
    }

    printf("\nAverage waiting time = %f", (float)total_wt / n);
    printf("\nAverage turnaround time = %f\n", (float)total_tat / n);
}

int main() {
    int n, quantum;

    printf("Enter the Number of Processes: ");
    scanf("%d", &n);

    int processes[n], burst_time[n];

    printf("\nEnter the quantum time: ");
    scanf("%d", &quantum);

    for (int i = 0; i < n; i++) {
        printf("\nEnter the process ID: ");
        scanf("%d", &processes[i]);
        printf("Enter the Burst Time: ");
        scanf("%d", &burst_time[i]);
    }
```

```
    findAvgTime(processes, n, burst_time, quantum);
    return 0;
}
```

OUTPUT:

```
Enter the Number of Processes: 5

Enter the quantum time: 2

Enter the process ID: 1
Enter the Burst Time: 5

Enter the process ID: 2
Enter the Burst Time: 3

Enter the process ID: 3
Enter the Burst Time: 1

Enter the process ID: 4
Enter the Burst Time: 2

Enter the process ID: 5
Enter the Burst Time: 3

Process ID        Burst Time        Waiting Time      Turnaround Time
1                 5                 9                 14
2                 3                 9                 12
3                 1                 4                 5
4                 2                 5                 7
5                 3                 10                13

Average waiting time = 7.400000
Average turnaround time = 10.200000
```

LAB - 3

Question 1:

Write a C program to simulate Real-Time CPU Scheduling algorithms:
(a)   Rate- Monotonic
(b)   Earliest-deadline First

```c
CODE:
#include <stdio.h>
#include <stdlib.h>
#include <math.h>
#include <stdbool.h>

#define MAX_PROCESS 10

typedef struct {
    int id;
    int burst_time;
    float priority;
} Task;

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

void get_process_info(int selected_algo)
{
    printf("Enter total number of processes (maximum %d): ", MAX_PROCESS);
    scanf("%d", &num_of_process);
    if (num_of_process < 1)
    {
        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];
        if (selected_algo == 2)
        {
            printf("==> Deadline: ");
            scanf("%d", &deadline[i]);
        }
        else
        {
            printf("==> Period: ");
            scanf("%d", &period[i]);
        }
    }
```

```c
}

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

int get_observation_time(int selected_algo)
{
    if (selected_algo == 1)
    {
        return max(period[0], period[1], period[2]);
    }
    else if (selected_algo == 2)
    {
        return max(deadline[0], deadline[1], deadline[2]);
    }
}

void print_schedule(int process_list[], int cycles)
{
    printf("\nScheduling:\n\n");
    printf("Time: ");
    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");
    }
}
```

```c
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 = (float) (n * (pow(2, 1.0 / n) - 1));
    if (utilization > m)
    {
        printf("\nGiven problem is not schedulable under the said scheduling 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)
            {
                if (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];
                next_process = k;
            }
        }
    }
    print_schedule(process_list, time);
}

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 n = num_of_process;
```

```
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];
}

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] == false)){
         execution_time[i] = remain_time[i];
```

```c
            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()
{
    int option;
    int observation_time;

    while (1)
    {
    printf("\n1. Rate Monotonic\n2. Earliest Deadline first\\n\nEnter your choice: ");
    scanf("%d", &option);
    switch(option)
    {
        case 1: get_process_info(option);
            observation_time = get_observation_time(option);
            rate_monotonic(observation_time);
            break;
        case 2: get_process_info(option);
            observation_time = get_observation_time(option);
            earliest_deadline_first(observation_time);
            break;

        case 3: exit (0);
        default: printf("\nInvalid Statement");
    }
    }
    return 0;
}
```

Output:
(a) Rate Monotonic:

```
1. Rate Monotonic
2. Earliest Deadline first

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

Given problem is not schedulable under the said scheduling algorithm.

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]: |    |    |####|####|    |    |    |    |    |    |    |####|####|    |
       |    |    |    |    |    |
```

(b) Earliest Deadline First:

```
1. Rate Monotonic
2. Earliest Deadline first

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

Process 1:
==> Execution time: 4
==> Deadline: 6

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

Scheduling:

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

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LAB - 4

Question 1:
Write a C program to simulate producer-consumer problem using semaphores.
Code:

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

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

int main()
{
    int n;
    void producer();
    void consumer();
    int wait(int);
    int signal(int);
    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!!");
                    break;
            case 2: if((mutex==1)&&(full!=0))
                    consumer();
                    else
                    printf("Buffer is empty!!");
                    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",x);
    mutex=signal(mutex);
}

void consumer()
{
    mutex=wait(mutex);
    full=wait(full);
    empty=signal(empty);

    printf("\nConsumer consumes item %d",x);
    x--;
    mutex=signal(mutex);
}
```

OUTPUT:

```
1.Producer
2.Consumer
3.Exit
Enter your choice: 1

Producer produces the item 1
Enter your choice: 1

Producer produces the item 2
Enter your choice: 2

Consumer consumes item 2
Enter your choice: 2

Consumer consumes item 1
Enter your choice: 1

Producer produces the item 1
Enter your choice: 2

Consumer consumes item 1
Enter your choice: 2
Buffer is empty!!
Enter your choice: 3
```

Question 2:
Write a C program to simulate the concept of Dining-Philosophers problem.
CODE:

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

#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;

                    sleep(2);

                    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]);
        sleep(1);
}

void put_fork(int i)
{
        sem_wait(&mutex);
        state[i] = THINKING;
```

```c
        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;
                sleep(1);
                take_fork(*i);
                sleep(0);
                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);
        }
}
```

OUTPUT:

```
Philosopher 1 is thinking
Philosopher 2 is thinking
Philosopher 3 is thinking
Philosopher 4 is thinking
Philosopher 5 is thinking
Philosopher 1 is Hungry
Philosopher 2 is Hungry
Philosopher 3 is Hungry
Philosopher 4 is Hungry
Philosopher 5 is Hungry
Philosopher 5 takes fork 4 and 5
Philosopher 5 is Eating
Philosopher 5 putting fork 4 and 5 down
```

LAB 5
Question 1:
Write a C program to simulate Bankers algorithm for the purpose of deadlock avoidance.

CODE:
```c
#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];
    printf("Enter the Allocation Matrix:\n");
    for (i = 0; i < n; i++)
    {
        for (j = 0; j < m; j++)
        {
            scanf("%d", &allocation[i][j]);
        }
    }

    int max[n][m];
    printf("Enter the MAX Matrix:\n");
    for (i = 0; i < n; i++)
    {
        for (j = 0; j < m; j++)
        {
            scanf("%d", &max[i][j]);
        }
    }

    int available[m];
    printf("Enter the Available Resources:\n");
    for (i = 0; i < m; i++)
    {
        scanf("%d", &available[i]);
    }

    int f[n], ans[n], ind = 0;
    for (k = 0; k < n; k++)
    {
        f[k] = 0;
    }

    int need[n][m];
    for (i = 0; i < n; i++)
```

```c
{
    for (j = 0; j < m; j++)
    {
        need[i][j] = max[i][j] - allocation[i][j];
    }
}

int y = 0;
for (k = 0; k < n; k++)
{
    for (i = 0; i < n; i++)
    {
        if (f[i] == 0)
        {
            int flag = 0;
            for (j = 0; j < m; j++)
            {
                if (need[i][j] > available[j])
                {
                    flag = 1;
                    break;
                }
            }

            if (flag == 0)
            {
                ans[ind++] = i;
                for (y = 0; y < m; y++)
                {
                    available[y] += allocation[i][y];
                }
                f[i] = 1;
            }
        }
    }
}

int flag = 1;
for (i = 0; i < n; i++)
{
    if (f[i] == 0)
    {
        flag = 0;
        printf("The following system is not safe\n");
        break;
    }
}

if (flag == 1)
{
    printf("Following is the SAFE Sequence\n");
    for (i = 0; i < n - 1; i++)
```

```
        {
            printf(" P%d ->", ans[i]);
        }
        printf(" P%d\n", ans[n - 1]);
    }
    return 0;
}
```
OUTPUT:

```
Enter the number of processes: 5
Enter the number of resources: 3
Enter the Allocation Matrix:
0 1 0
2 0 0
3 0 2
2 1 1
0 0 2
Enter the MAX Matrix:
7 5 3
3 2 2
9 0 2
2 2 2
4 3 3
Enter the Available Resources:
3 3 2
Following is the SAFE Sequence
 P1 -> P3 -> P4 -> P0 -> P2
```

Question 2:
Write a C program to simulate deadlock detection.
CODE:
```c
#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 no of process: ");
scanf("%d",&np);
printf("\nEnter the no of resources: ");
scanf("%d",&nr);
for(i=0;i<nr;i++)
{
printf("\nTotal Amount of the Resource R%d: ",i+1);
scanf("%d",&r[i]);
}

printf("\nEnter the request matrix:");

for(i=0;i<np;i++)
for(j=0;j<nr;j++)
scanf("%d",&request[i][j]);

printf("\nEnter the allocation matrix:");
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;


if(deadlock)
printf("\n Deadlock detected");
else
printf("\n No Deadlock possible");
}
```

OUTPUT:

```
Enter the no of process: 5

Enter the no of resources: 3

Total Amount of the Resource R1: 0

Total Amount of the Resource R2: 0

Total Amount of the Resource R3: 0

Enter the request matrix:0 0 0
2 0 2
0 0 0
1 0 0
0 0 2

Enter the allocation matrix:0 1 0
2 0 0
3 0 3
2 1 1
0 0 2

 Deadlock detected
```

LAB 6
Question 1:
Write a C program to simulate the following contiguous memory allocation techniques:
(a) **Worst-fit**

(b) **Best-fit**

(c) **First-fit**

CODE:
```c
#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 = 1; i <= nb; i++)
    {
        printf("Block %d:", i);
        scanf("%d", &b[i]);
    }

    printf("\nEnter the size of the files:\n");
    for (int i = 1; i <= nf; i++)
    {
        printf("File %d:", i);
        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);
```

```c
        return 0;
}

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

    for (i = 1; i <= nf; i++)
    {
        for (j = 1; j <= nb; j++)
        {
            if (bf[j] != 1 && 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 (i = 1; i <= nf; i++)
    {
        printf("\n%d\t\t%d\t\t%d\t\t%d\t\t%d", i, f[i], ff[i], b[ff[i]], frag[i]);
    }
}

void worstFit(int b[], int nb, int f[], int nf)
{
    int bf[max] = {0};
    int ff[max] = {0};
    int frag[max], i, j, temp, highest = 0;

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

```
        bf[ff[i]] = 1;
        highest = 0;
    }

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

void bestFit(int b[], int nb, int f[], int nf)
{
    int bf[max] = {0};
    int ff[max] = {0};
    int frag[max], i, j, temp, lowest = 10000;

    for (i = 1; i <= nf; i++)
    {
        for (j = 1; j <= nb; j++)
        {
            if (bf[j] != 1)
            {
                temp = b[j] - f[i];
                if (temp >= 0 && lowest > temp)
                {
                    ff[i] = j;
                    lowest = temp;
                }
            }
        }
        frag[i] = lowest;
        bf[ff[i]] = 1;
        lowest = 10000;
    }

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

OUTPUT:

```
Memory Management Schemes

Enter the number of blocks:5
Enter the number of files:5

Enter the size of the blocks:
Block 1:100
Block 2:500
Block 3:200
Block 4:300
Block 5:600

Enter the size of the files:
File 1:212
File 2:415
File 3:63
File 4:200
File 5:255
Memory Management Scheme - First Fit
File_no:       File_size:      Block_no:       Block_size:    Fragment
1              212             2               500            288
2              415             5               600            185
3              63              1               100            37
4              200             3               200            0
5              255             4               300            45

Memory Management Scheme - Worst Fit
File_no:       File_size:      Block_no:       Block_size:    Fragment
1              212             5               600            388
2              415             2               500            85
3              63              4               300            237
4              200             0               0              0
5              255             0               0              0

Memory Management Scheme - Best Fit
File_no:       File_size:      Block_no:       Block_size:    Fragment
1              212             4               300            88
2              415             2               500            85
3              63              1               100            37
4              200             3               200            0
5              255             5               600            345
```

Question 2:
Write a C program to simulate page replacement algorithms:
(a) **FIFO**

(b) **LRU**

(c) **Optimal**

CODE:

```c
#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 no 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;
}

int getHitIndex(int data)
{
    int hitind;
    for(k=0; k<f; k++)
```

```c
    {
        if(p[k]==data)
        {
            hitind=k;
            break;
        }
    }
    return hitind;
}

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

void dispPgFaultCnt()
{
    printf("\nTotal no of page faults:%d",pgfaultcnt);
}

void fifo()
{
    getdata();
    initialize();
    for(i=0; i<n; i++)
    {
        printf("\nFor %d :",in[i]);
//not a hit
        if(isHit(in[i])==0)
        {

            for(k=0; k<f-1; k++)
                p[k]=p[k+1];

            p[k]=in[i];
            pgfaultcnt++;
            dispPages();
        }
        else
            printf("No page fault");
    }
    dispPgFaultCnt();
}


void optimal()
{
    initialize();
```

```c
    int near[50];
    for(i=0; i<n; i++)
    {

        printf("\nFor %d :",in[i]);

        if(isHit(in[i])==0)
        {

            for(j=0; j<f; j++)
            {
                int pg=p[j];
                int found=0;
                for(k=i; k<n; k++)
                {
                    if(pg==in[k])
                    {
                        near[j]=k;
                        found=1;
                        break;
                    }
                    else
                        found=0;
                }
                if(!found)
                    near[j]=9999;
            }
            int max=-9999;
            int repindex;
            for(j=0; j<nf; j++)
            {
                if(near[j]>max)
                {
                    max=near[j];
                    repindex=j;
                }
            }
            p[repindex]=in[i];
            pgfaultcnt++;

            dispPages();
        }
        else
            printf("No page fault");
    }
    dispPgFaultCnt();
}

void lru()
{
    initialize();
```

```c
    int least[50];
    for(i=0; i<n; i++)
    {

        printf("\nFor %d :",in[i]);

        if(isHit(in[i])==0)
        {

            for(j=0; j<nf; 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;
                    }
                    else
                        found=0;
                }
                if(!found)
                    least[j]=-9999;
            }
            int min=9999;
            int repindex;
            for(j=0; j<nf; j++)
            {
                if(least[j]<min)
                {
                    min=least[j];
                    repindex=j;
                }
            }
            p[repindex]=in[i];
            pgfaultcnt++;

            dispPages();
        }
        else
            printf("No page fault!");
    }
    dispPgFaultCnt();
}

int main()
{
    int choice;
    while(1)
```

```
    {
        printf("\nPage Replacement Algorithms\n1.Enter data\n2.FIFO\n3.Optimal\n4.LRU\n5.Exit\nEnter your choice:");
        scanf("%d",&choice);
        switch(choice)
        {
        case 1: getData();
            break;
        case 2: fifo();
            break;
        case 3: optimal();
            break;
        case 4: lru();
            break;
        default: return 0;
             break;
        }
    }
}
```

OUTPUT:

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

Enter length of page reference sequence:12

Enter the page reference sequence:1 2 3 4 1 2 5 1 2 3 4 5

Enter no of frames:3

For 1 : 1
For 2 : 1 2
For 3 : 1 2 3
For 4 : 2 3 4
For 1 : 3 4 1
For 2 : 4 1 2
For 5 : 1 2 5
For 1 :No page fault
For 2 :No page fault
For 3 : 2 5 3
For 4 : 5 3 4
For 5 :No page fault
Total no of page faults:9
```

```
Enter your choice:3

For 1 : 1
For 2 : 1 2
For 3 : 1 2 3
For 4 : 1 2 4
For 1 :No page fault
For 2 :No page fault
For 5 : 1 2 5
For 1 :No page fault
For 2 :No page fault
For 3 : 3 2 5
For 4 : 4 2 5
For 5 :No page fault
Total no of page faults:7
Page Replacement Algorithms
1.Enter data
2.FIFO
3.Optimal
4.LRU
5.Exit
Enter your choice:4

For 1 : 1
For 2 : 1 2
For 3 : 1 2 3
For 4 : 4 2 3
For 1 : 4 1 3
For 2 : 4 1 2
For 5 : 5 1 2
For 1 :No page fault!
For 2 :No page fault!
For 3 : 3 1 2
For 4 : 3 4 2
For 5 : 3 4 5
Total no of page faults:10
```

LAB 7
Question 1:
Write a C program to simulate the disk scheduling algorithms.
(a)FCFS
(b)SCAN
(c)C-SCAN

(a) FCFS:
CODE:
```
#include<stdio.h>
#include<stdlib.h>
int main()
{
   int RQ[100],i,n,TotalHeadMoment=0,initial;
   printf("Enter the number of Requests\n");
   scanf("%d",&n);
   printf("Enter the Requests sequence\n");
   for(i=0;i<n;i++)
    scanf("%d",&RQ[i]);
   printf("Enter initial head position\n");
   scanf("%d",&initial);

   for(i=0;i<n;i++)
   {
      TotalHeadMoment=TotalHeadMoment+abs(RQ[i]-initial);
      initial=RQ[i];
   }

   printf("Total head moment is %d",TotalHeadMoment);
   return 0;

}
```
OUTPUT:
```
Enter the number of Requests
8
Enter the Requests sequence
98 183 37 122 14 124 65 67
Enter initial head position
53
Total head moment is 640
```

(b) SCAN:
   CODE:

```c
#include<stdio.h>
#include<stdlib.h>
int main()
{
    int RQ[100],i,j,n,TotalHeadMoment=0,initial,size,move;
    printf("Enter the number of Requests\n");
    scanf("%d",&n);
    printf("Enter the Requests sequence\n");
    for(i=0;i<n;i++)
     scanf("%d",&RQ[i]);
    printf("Enter initial head position\n");
    scanf("%d",&initial);
    printf("Enter total disk size\n");
    scanf("%d",&size);
    printf("Enter the head movement direction for high 1 and for low 0\n");
    scanf("%d",&move);

    for(i=0;i<n;i++)
    {
       for(j=0;j<n-i-1;j++)
       {
          if(RQ[j]>RQ[j+1])
          {
             int temp;
             temp=RQ[j];
             RQ[j]=RQ[j+1];
             RQ[j+1]=temp;
          }

       }
    }

    int index;
    for(i=0;i<n;i++)
    {
       if(initial<RQ[i])
       {
          index=i;
```

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```c
            break;
        }
    }

    if(move==1)
    {
        for(i=index;i<n;i++)
        {
            TotalHeadMoment=TotalHeadMoment+abs(RQ[i]-initial);
            initial=RQ[i];
        }

        TotalHeadMoment=TotalHeadMoment+abs(size-RQ[i-1]-1);
        initial = size-1;
        for(i=index-1;i>=0;i--)
        {
            TotalHeadMoment=TotalHeadMoment+abs(RQ[i]-initial);
            initial=RQ[i];

        }
    }
    else
    {
        for(i=index-1;i>=0;i--)
        {
            TotalHeadMoment=TotalHeadMoment+abs(RQ[i]-initial);
            initial=RQ[i];
        }
            TotalHeadMoment=TotalHeadMoment+abs(RQ[i+1]-0);
        initial =0;
        for(i=index;i<n;i++)
        {
            TotalHeadMoment=TotalHeadMoment+abs(RQ[i]-initial);
            initial=RQ[i];
        }
    }

    printf("Total head movement is %d",TotalHeadMoment);
    return 0;
}
```

OUTPUT:

```
Enter the number of Requests
8
Enter the Requests sequence
98 183 37 122 14 124 65 67
Enter initial head position
53
Enter total disk size
199
Enter the head movement direction for high 1 and for low 0
0
Total head movement is 236
```

(d) C-SCAN:

CODE:

```c
#include<stdio.h>
#include<stdlib.h>
int main()
{
    int RQ[100],i,j,n,TotalHeadMoment=0,initial,size,move;
    printf("Enter the number of Requests\n");
    scanf("%d",&n);
    printf("Enter the Requests sequence\n");
    for(i=0;i<n;i++)
     scanf("%d",&RQ[i]);
    printf("Enter initial head position\n");
    scanf("%d",&initial);
    printf("Enter total disk size\n");
    scanf("%d",&size);
    printf("Enter the head movement direction for high 1 and for low 0\n");
    scanf("%d",&move);


    for(i=0;i<n;i++)
    {
        for( j=0;j<n-i-1;j++)
        {
            if(RQ[j]>RQ[j+1])
            {
                int temp;
                temp=RQ[j];
```

```
            RQ[j]=RQ[j+1];
            RQ[j+1]=temp;
         }


     }
}


int index;
for(i=0;i<n;i++)
{
    if(initial<RQ[i])
    {
        index=i;
        break;
    }
}


if(move==1)
{
    for(i=index;i<n;i++)
    {
        TotalHeadMoment=TotalHeadMoment+abs(RQ[i]-initial);
        initial=RQ[i];
    }
    TotalHeadMoment=TotalHeadMoment+abs(size-RQ[i-1]-1);
    TotalHeadMoment=TotalHeadMoment+abs(size-1-0);
    initial=0;
    for( i=0;i<index;i++)
    {
         TotalHeadMoment=TotalHeadMoment+abs(RQ[i]-initial);
         initial=RQ[i];

    }
}
else
{
    for(i=index-1;i>=0;i--)
    {
        TotalHeadMoment=TotalHeadMoment+abs(RQ[i]-initial);
        initial=RQ[i];
    }
```

```
        TotalHeadMoment=TotalHeadMoment+abs(RQ[i+1]-0);


        TotalHeadMoment=TotalHeadMoment+abs(size-1-0);
        initial =size-1;
        for(i=n-1;i>=index;i--)
        {
            TotalHeadMoment=TotalHeadMoment+abs(RQ[i]-initial);
            initial=RQ[i];
        }
    }

    printf("Total head movement is %d",TotalHeadMoment);
    return 0;
}
```

OUTPUT:

```
Enter the number of Requests
8
Enter the Requests sequence
98 183 37 122 14 124 65 67
Enter initial head position
53
Enter total disk size
199
Enter the head movement direction for high 1 and for low 0
0
Total head movement is 384
```