VISVESVARAYA TECHNOLOGICAL UNIVERSITY

"JnanaSangama", Belgaum -590014, Karnataka.

LAB REPORT

on

Operating Systems

(23CS4PCOPS)

Submitted by:

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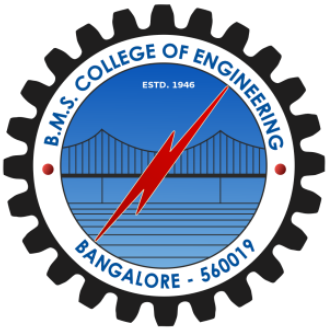
in partial fulfillment for the award of the degree of

BACHELOR OF ENGINEERING

in

COMPUTER SCIENCE AND ENGINEERING



B.M.S. COLLEGE OF ENGINEERING

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Department of Computer Science and Engineering

CERTIFICATE

This is to certify that the Lab work entitled "**Operating Systems**" carried out by **Arugunta Hamsika (1BM22CS054),** 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 2023-24. 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

1.Question:

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:

```
#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%d", i+1, Burst_time[i], Waiting_time[i], Turn_around_time[i]);
   }
   avg_Waiting_time = (float)avg_Waiting_time / n;
   avg_Turn_around_time = (float)avg_Turn_around_time / n;
   printf("\nAverage Waiting Time: %.2f", avg_Waiting_time);
   printf("\nAverage Turnaround Time: %.2f\n", avg_Turn_around_time);
   return 0;
}

int SJF() {
   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_around_time[i]);
    }
    avg_Turn_around_time = (float)total / n;
    printf("\n\nAverage Waiting Time=%.2f", avg_Waiting_time);
    printf("\nAverage Turnaround Time=%.2f\n", avg_Turn_around_time);
    return 0;
}
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("Enter your choice: ");
        scanf("%d", &choice);
        switch(choice) {
            case 1: FCFS();
                    break;
            case 2: SJF();
                    break;
            default: printf("Invalid Input!!!\n");
        }
    }
    return 0;
}
```

Output:

```
Arugunta Hamsika-1BM22CS054
Enter the total number of processes: 4
Enter Burst Time:
P[1]: 8
P[2]: 4
P[3]: 9
P[4]: 5
-----MAIN MENU-----
1. FCFS Scheduling
2. SJF Scheduling
Enter your choice: 1
Process     Burst Time      Waiting Time        Turnaround Time
P[1]        8           0               8
P[2]        4           8               12
P[3]        9           12              21
P[4]        5           21              26
Average Waiting Time: 10.25
Average Turnaround Time: 16.75

-----MAIN MENU-----
1. FCFS Scheduling
2. SJF Scheduling
Enter your choice: 2
Process     Burst Time      Waiting Time        Turnaround Time
P[2]        4           0               4
P[4]        5           4               9
P[1]        8           9               17
P[3]        9           17              26

Average Waiting Time=7.50
Average Turnaround Time=14.00
```

LAB - 2

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) Priority (Non-pre-emptive)

```
#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("Arugunta Hamsika-1BM22CS054\n");
    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;
}

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 += wt[i];
        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);
}
```

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;
};
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;
            }
        }
        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) {
}
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);
}
```

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

```
#include <stdio.h>
#include <stdbool.h>
#define MAX_PROCESSES 10
struct Process {
    int pid;
    int burst_time;
    int arrival_time;
    int remaining_time;
    int turnaround_time;
    int waiting_time;
    int completion_time;
};
void round_robin(struct Process proc[], int n, int quantum) {
    int current_time = 0;
    int completed_processes = 0;
    while (completed_processes < n) {
        bool process_found = false;
        for (int i = 0; i < n; i++) {
            if (proc[i].remaining_time > 0 && proc[i].arrival_time <= current_time) {
                process_found = true;
                if (proc[i].remaining_time > quantum) {
                    current_time += quantum;
                        proc[i].remaining_time -= quantum;
                } else {
                    current_time += proc[i].remaining_time;
                    proc[i].completion_time = current_time;
                    proc[i].turnaround_time = proc[i].completion_time - proc[i].arrival_time;
                    proc[i].waiting_time = proc[i].turnaround_time - proc[i].burst_time;
                    proc[i].remaining_time = 0;
                        completed_processes++;
```

```
            }
        }
    }
    if (!process_found) {
        current_time++;
    }
}
// Print the results
printf("\nPID\tArrival Time\tBurst Time\tCompletion Time\tTurnaround Time\tWaiting Time\n");
float total_completion_time = 0, total_turnaround_time = 0, total_waiting_time = 0;
for (int i = 0; i < n; i++) {
    printf("%d\t%d\t\t%d\t\t%d\t\t%d\t\t%d\n", proc[i].pid, proc[i].arrival_time, proc[i].burst_time,
proc[i].completion_time, proc[i].turnaround_time, proc[i].waiting_time);
    total_completion_time += proc[i].completion_time;
    total_turnaround_time += proc[i].turnaround_time;
    total_waiting_time += proc[i].waiting_time;
}
// Calculate and display averages
printf("\nAverage Completion Time: %.2f\n", total_completion_time / n);
printf("Average Turnaround Time: %.2f\n", total_turnaround_time / n);
printf("Average Waiting Time: %.2f\n", total_waiting_time / n);
}
int main() {
    int n, quantum;
    printf("Arugunta hamsika-1BM22CS054\n");
    printf("Enter the total number of processes (max %d): ", MAX_PROCESSES);
    scanf("%d", &n);
    if (n > MAX_PROCESSES) {
        printf("Number of processes exceeds maximum limit.\n");
        return 1;
    }
    struct Process proc[MAX_PROCESSES];
```

```
    printf("Enter Arrival Time and Burst Time for each process:\n");
    for (int i = 0; i < n; i++) {
        printf("Process %d:\n", i + 1);
        printf("Arrival Time: ");
        scanf("%d", &proc[i].arrival_time);
        printf("Burst Time: ");
        scanf("%d", &proc[i].burst_time);
        proc[i].pid = i + 1;
        proc[i].remaining_time = proc[i].burst_time; // Initialize remaining time
        proc[i].turnaround_time = 0; // Initialize turnaround time
        proc[i].waiting_time = 0; // Initialize waiting time
        proc[i].completion_time = 0; // Initialize completion time
    }

    printf("Enter Time Quantum: ");
    scanf("%d", &quantum);

    round_robin(proc, n, quantum);

    return 0;
}
```

Output:

(a) Priority (Non-pre-emptive)

```
Arugunta Hamsika-1BM22CS054
Enter the number of processes: 3
Enter the process ID: 1
Enter the burst time: 2
Enter the priority: 3
Enter the process ID: 2
Enter the burst time: 5
Enter the priority: 2
Enter the process ID: 3
Enter the burst time: 6
Enter the priority: 1
Process ID  Burst Time  Priority    Waiting Time    Turnaround Time
3       6       1       0       6
2       5       2       6       11
1       2       3       11      13

Average Waiting Time = 5.666667
Average Turnaround Time = 10.000000
```

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

```
Arugunta hamsika-1BM22CS054
Enter the total number of processes (max 10): 4
Enter Arrival Time and Burst Time for each process:
Process 1:
Arrival Time: 5
Burst Time: 5
Process 2:
Arrival Time: 4
Burst Time: 6
Process 3:
Arrival Time: 3
Burst Time: 7
Process 4:
Arrival Time: 1
Burst Time: 9
Enter Time Quantum: 4
PID Arrival Time    Burst Time  Completion Time Turnaround Time Waiting Time
1   5       5       22      17      12
2   4       6       24      20      14
3   3       7       27      24      17
4   1       9       28      27      18

Average Completion Time: 25.25
Average Turnaround Time: 22.00
Average Waiting Time: 15.25
```

LAB- 3

3-Question:

Write a C program to simulate multi-level queue scheduling algorithm considering the following scenario. All the processes in the system are divided into two categories – system processes and user processes. System processes are to be given higher priority than user processes. Use FCFS scheduling for the processes in each queue.

Code:

```
#include <stdio.h>
#include <stdlib.h>
struct process {
    int pid;
    int arrival_time;
    int burst_time;
    int priority;
    int waiting_time;
    int turnaround_time;
};
void FCFS(struct process *queue, int n) {
    int i, j;
    struct process temp;
    for (i = 0; i < n; i++) {
        for (j = i + 1; j < n; j++) {
            if (queue[i].arrival_time > queue[j].arrival_time) {
                temp = queue[i];
                queue[i] = queue[j];
                queue[j] = temp;
            }
        }
    }
}

int main() {
    int n, i;
    struct process *system_queue, *user_queue;
    int system_n = 0, user_n = 0;
    float avg_waiting_time = 0, avg_turnaround_time = 0;
    printf("Arugunta Hamsika-1BM22CS054\n");
    printf("Enter the number of processes: ");
    scanf("%d", &n);
    system_queue = (struct process *) malloc(n * sizeof(struct process));
    user_queue = (struct process *) malloc(n * sizeof(struct process));
    for (i = 0; i < n; i++) {
        struct process p;
        printf("Enter arrival time, burst time, and priority (0-System/1-User) for process %d: ", i + 1);
        scanf("%d %d %d", &p.arrival_time, &p.burst_time, &p.priority);
        p.pid = i + 1;
        p.waiting_time = 0;
```

```
        p.turnaround_time = 0;
        if (p.priority == 0) {
            system_queue[system_n++] = p;
        } else {
            user_queue[user_n++] = p;
        }
    }

    FCFS(system_queue, system_n);
    FCFS(user_queue, user_n);
    int time = 0;
    int s = 0, u = 0;
    while (s < system_n || u < user_n) {
        if (s < system_n && system_queue[s].arrival_time <= time) {
            if (u < user_n && user_queue[u].arrival_time <= time && user_queue[u].arrival_time <
system_queue[s].arrival_time) {
                user_queue[u].waiting_time = time - user_queue[u].arrival_time;
                time += user_queue[u].burst_time;
                user_queue[u].turnaround_time = user_queue[u].waiting_time + user_queue[u].burst_time;
                avg_waiting_time += user_queue[u].waiting_time;
                avg_turnaround_time += user_queue[u].turnaround_time;
                u++;
            } else {
                system_queue[s].waiting_time = time - system_queue[s].arrival_time;
                time += system_queue[s].burst_time;
                system_queue[s].turnaround_time = system_queue[s].waiting_time + system_queue[s].burst_time;
                avg_waiting_time += system_queue[s].waiting_time;
                avg_turnaround_time += system_queue[s].turnaround_time;
                s++;
            }
        } else if (u < user_n && user_queue[u].arrival_time <= time) {
            user_queue[u].waiting_time = time - user_queue[u].arrival_time;
            time += user_queue[u].burst_time;
            user_queue[u].turnaround_time = user_queue[u].waiting_time + user_queue[u].burst_time;
            avg_waiting_time += user_queue[u].waiting_time;
            avg_turnaround_time += user_queue[u].turnaround_time;
              u++;
        } else {
            if (s < system_n && system_queue[s].arrival_time <= user_queue[u].arrival_time) {
                time = system_queue[s].arrival_time;
            } else {
                time = user_queue[u].arrival_time;
            }
        }
     }
    avg_waiting_time /= n;
    avg_turnaround_time /= n;
    printf("PID\tBurst Time\tPriority\tQueue Type\tWaiting Time\tTurnaround Time\n");
    for (i = 0; i < system_n; i++) {
        printf("%d\t%d\t\t%d\t\tSystem\t\t%d\t\t%d\n", system_queue[i].pid, system_queue[i].burst_time,
system_queue[i].priority, system_queue[i].waiting_time, system_queue[i].turnaround_time);
    }
```

```
    for (i = 0; i < user_n; i++) {
        printf("%d\t%d\t\t%d\t\tUser\t\t%d\t\t%d\n", user_queue[i].pid, user_queue[i].burst_time,
user_queue[i].priority, user_queue[i].waiting_time, user_queue[i].turnaround_time);
    }
    printf("Average Waiting Time: %.2f\n", avg_waiting_time);
    printf("Average Turnaround Time: %.2f\n", avg_turnaround_time);
    free(system_queue);
    free(user_queue);
    return 0;
}
```

Output:

```
Arugunta Hamsika-1BM22CS054
Enter the number of processes: 4
Enter arrival time, burst time, and priority (0-System/1-User) for process 1:
    0 5 0
Enter arrival time, burst time, and priority (0-System/1-User) for process 2:
    2 3 1
Enter arrival time, burst time, and priority (0-System/1-User) for process 3:
    1 2 0
Enter arrival time, burst time, and priority (0-System/1-User) for process 4:
    4 4 1
PID Burst Time  Priority    Queue Type  Waiting Time    Turnaround Time
1   5       0       System      0       5
3   2       0       System      4       6
2   3       1       User        5       8
4   4       1       User        6       10
Average Waiting Time: 3.75
Average Turnaround Time: 7.25
```

LAB- 3

4-Question:

Write a C program to simulate Real-Time CPU Scheduling algorithms:

(a) Rate- Monotonic

(b) Earliest-deadline First

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]);
        }
    }
}

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");
    }
}

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];
            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\n3. Proportional Scheduling\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\n");
        }
    }
    return 0;
}
```

Output:

(a) Rate Monotonic:

```
Arugunta Hamsika-1BM22Cs054

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

Enter your choice: 1
Enter total number of processes (maximum 10): 2
Process 1:
==> Execution time: 4
==> Period: 6
Process 2:
==> Execution time: 6
==> Period: 2
Given problem is not schedulable under the said scheduling algorithm.

Scheduling:

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

(b) Earliest Deadline First:

```
Arugunta Hamsika-1BM22Cs054

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

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

LAB- 4

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

Code:

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

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

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

int main() {
   int n;
   printf("Arugunta Hamsika-1BM22CS054\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;
         default:
            printf("Invalid choice\n");
            break;
      }
   }
   return 0;
}

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

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

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

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

Output:

```
Arugunta Hamsika-1BM22CS054

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 1

Enter your choice: 3
```

LAB - 4

6-Question:

Write a C program to simulate the concept of Dining-Philosophers problem.

Code:

```
#include <stdio.h>
#include <pthread.h>
#include <semaphore.h>
#include <unistd.h> // for sleep function
#define N 5
#define THINKING 2
#define HUNGRY 1
#define EATING 0
#define LEFT (i + N - 1) % 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); // Eating for some time
      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); // Waiting for a moment after picking up forks
}

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;
        sleep(1); // Thinking for a while
        take_fork(*i);
        sleep(0); // Slight delay
        put_fork(*i);
    }
}

int main()
{
    int i;
    printf("Arugunta Hamsika-1BM22CS054\n");
    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:

```
Arugunta Hamsika-1BM22CS054
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
Philosopher 5 is thinking
Philosopher 4 takes fork 3 and 4
Philosopher 4 is Eating
Philosopher 1 takes fork 5 and 1
Philosopher 1 is Eating
Philosopher 4 putting fork 3 and 4 down
Philosopher 4 is thinking
Philosopher 3 takes fork 2 and 3
Philosopher 3 is Eating
Philosopher 5 is Hungry
Philosopher 1 putting fork 5 and 1 down
Philosopher 1 is thinking
Philosopher 5 takes fork 4 and 5
Philosopher 5 is Eating
Philosopher 4 is Hungry
Philosopher 3 putting fork 2 and 3 down
Philosopher 3 is thinking
Philosopher 2 takes fork 1 and 2
```

LAB - 5

7-Question:

Write a C program to simulate Bankers algorithm for the purpose of deadlock avoidance.

Code:

```
#include <stdio.h>
int main()
{
   int n, m, i, j, k;
   printf("Arugunta hamsika-1BM22CS054\n");
   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++)
{
   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 safe = 1;
for (i = 0; i < n; i++)
{
   if (f[i] == 0)
   {
      safe = 0;
      printf("The system is not in a safe state\n");
      break;
   }
}

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

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

    return 0;
}
```

Output:

```
Arugunta hamsika-1BM22CS054
Enter the number of processes: 3
Enter the number of resources: 3
Enter the Allocation Matrix:
0 1 0
2 0 0
3 0 2
Enter the MAX Matrix:
7 5 3
3 2 2
9 0 2
Enter the Available Resources:
3 3 2
The system is not in a safe state
```

```
Arugunta hamsika-1BM22CS054
Enter the number of processes: 3
Enter the number of resources: 3
Enter the Allocation Matrix:
1 0 0
0 2 0
1 1 1
Enter the MAX Matrix:
1 2 1
1 3 1
1 3 2
Enter the Available Resources:
1 1 1
Following is the SAFE Sequence: P1 -> P2 -> P0
```

LAB- 5

8-Question:
Write a C program to simulate deadlock detection.

Code:

```
#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("Arugunta Hamsika-1BM22CS054\n");
   printf("\nEnter the number of processes: ");
   scanf("%d", &np);
   printf("Enter the number of resources: ");
   scanf("%d", &nr);
   for (i = 0; i < nr; i++)
   {
      printf("Total Amount of the 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]);
      }
   }
   /* Available Resource calculation */
   for (j = 0; j < nr; j++)
   {
      avail[j] = r[j];
      for (i = 0; i < np; i++)
      {
         avail[j] -= alloc[i][j];
      }
   } // Marking processes with zero allocation
   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;
}

// Initialize W with avail
for (j = 0; j < nr; j++)
   w[j] = avail[j];

// Mark processes with request less than or equal to W
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];
      }
   }
}

// Checking for unmarked processes
int deadlock = 0;
for (i = 0; i < np; i++)
{
   if (mark[i] != 1)
      deadlock = 1;
}

if (deadlock)
   printf("\nDeadlock detected\n");
```

```
    else
        printf("\nNo Deadlock possible\n");

    return 0;
}
```

Output:

```
Arugunta Hamsika-1BM22CS054

Enter the number of processes: 3
Enter the number of resources: 3
Total Amount of the Resource R1: 7
Total Amount of the Resource R2: 2
Total Amount of the Resource R3: 6
Enter the request matrix:
0 1 0
2 0 0
3 0 2
Enter the allocation matrix:
0 0 0
2 0 0
3 0 2
No Deadlock possible
```

```
Arugunta Hamsika-1BM22CS054

Enter the number of processes: 5
Enter the number 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

9-Question:
Write a C program to simulate the following contiguous memory allocation techniques:
(a) Worst-fit
(b) Best-fit
(c) First-fit

Code:

```
#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);

   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:

```
Enter the number of blocks: 3
Enter the number of files: 4
Enter the size of the blocks:
Block 1: 10
Block 2: 5
Block 3: 20
Enter the size of the files:
File 1: 12
File 2: 7
File 3: 10
File 4: 15
Memory Management Scheme - First Fit
File_no:    File_size:  Block_no:   Block_size: Fragment
1       12      1       10      8
2       7       Not Allocated   Not Allocated   Not Allocated
3       10      3       20      0
4       15      Not Allocated   Not Allocated   Not Allocated


Memory Management Scheme - Worst Fit
File_no:    File_size:  Block_no:   Block_size: Fragment
1       12      1       10      8
2       7       Not Allocated   Not Allocated   Not Allocated
3       10      3       20      0
4       15      Not Allocated   Not Allocated   Not Allocated


Memory Management Scheme - Best Fit
File_no:    File_size:  Block_no:   Block_size: Fragment
1       12      1       10      8
2       7       Not Allocated   Not Allocated   Not Allocated
3       10      3       20      0
4       15      Not Allocated   Not Allocated   Not Allocated
```

10-Question :
Write a C program to simulate page replacement algorithms:
(a) FIFO
(b) LRU
(c) Optimal

Code:

```
#include <stdio.h>

#define MAX_FRAMES 50
#define MAX_PAGES 100

int n, f, pgfaultcnt = 0;
int in[MAX_PAGES];
int p[MAX_FRAMES];

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

void initialize() {
   pgfaultcnt = 0;
   for (int i = 0; i < f; i++)
      p[i] = -1; // Initialize frame values to -1 (indicating empty frame)
}

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

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

void dispPages() {
   for (int k = 0; k < f; k++) {
```

```
        if (p[k] != -1)
            printf(" %d", p[k]);
    }
}

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

void fifo() {
    initialize();
    int frame_index = 0;

    for (int i = 0; i < n; i++) {
        printf("\nFor %d :", in[i]);

        if (!isHit(in[i])) {
            p[frame_index] = in[i];
            frame_index = (frame_index + 1) % f;
            pgfaultcnt++;
            dispPages();
        } else {
            printf(" No page fault");
        }
    }

    dispPgFaultCnt();
}

void optimal() {
    initialize();

    for (int i = 0; i < n; i++) {
        printf("\nFor %d :", in[i]);

        if (!isHit(in[i])) {
            int farthest = i;
            int replace_index = 0;

            for (int j = 0; j < f; j++) {
                int current_page = p[j];
                int found = 0;

                for (int k = i; k < n; k++) {
                    if (current_page == in[k]) {
                        if (k > farthest) {
                            farthest = k;
                            replace_index = j;
                        }
                        found = 1;
                        break;
                    }
```

```
            }

            if (!found) {
                replace_index = j;
                break;
            }
        }

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

  dispPgFaultCnt();
}

void lru() {
  initialize();
  int used[MAX_FRAMES] = {0};

  for (int i = 0; i < n; i++) {
    printf("\nFor %d :", in[i]);

    if (!isHit(in[i])) {
        int replace_index = 0;
        int least_used = used[0];

        for (int j = 0; j < f; j++) {
            if (used[j] < least_used) {
                least_used = used[j];
                replace_index = j;
            }
        }

        p[replace_index] = in[i];
        used[replace_index] = i + 1; // Update least recently used time
        pgfaultcnt++;
        dispPages();
    } else {
        printf(" No page fault");
        used[getHitIndex(in[i])] = i + 1; // Update recently used time
    }
  }

  dispPgFaultCnt();
}

int main() {
  int choice;
```

```
    printf("Arugunta hamsika-1BM22CS054\n");
    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!\n");
                break;
        }
    }

    return 0;
}
```

Output:

```
Arugunta hamsika-1BM22CS054

Page Replacement Algorithms
1. Enter data
2. FIFO
3. Optimal
4. LRU
5. Exit
Enter your choice: 1
Enter length of page reference sequence: 10
Enter the page reference sequence:
7 0 1 2 0 3 0 4 2 3
Enter number of frames: 3
Page Replacement Algorithms
1. Enter data
2. FIFO
3. Optimal
4. LRU
5. Exit
Enter your choice: 2
For 7 : 7
For 0 : 7 0
For 1 : 7 0 1
For 2 : 2 0 1
For 0 : No page fault
For 3 : 2 3 1
For 0 : 2 3 0
For 4 : 4 3 0
For 2 : 4 2 0
For 3 : 4 2 3
Total number of page faults: 9
```

LAB-7
11-Question:
Write a C program to simulate disk scheduling algorithms:
(a) FCFS

Code:

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

int main() {
   int RQ[100], i, n, TotalHeadMoment = 0, initial;
   printf("Arugunta Hamsika-1BM22Cs054\n");
   printf("Enter the number of requests: ");
   scanf("%d", &n);

   printf("Enter the request sequence: ");
   for (i = 0; i < n; i++)
      scanf("%d", &RQ[i]);

   printf("Enter initial head position: ");
   scanf("%d", &initial);

   // FCFS disk scheduling logic
   for (i = 0; i < n; i++) {
      TotalHeadMoment += abs(RQ[i] - initial);
      initial = RQ[i];
   }

   printf("Total head movement is %d\n", TotalHeadMoment);

   return 0;
}
```

Output:

```
Arugunta Hamsika-1BM22Cs054
Enter the number of requests: 8
Enter the request sequence: 95
180
34
119
11
123
62
64
Enter initial head position: 50
Total head movement is 644
```

(b) SCAN

Code:

```
#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: ");
   scanf("%d", &n);

   printf("Enter the Requests sequence: ");
   for (i = 0; i < n; i++)
      scanf("%d", &RQ[i]);

   printf("Enter initial head position: ");
   scanf("%d", &initial);

   printf("Enter total disk size: ");
   scanf("%d", &size);

   printf("Enter the head movement direction (1 for high, 0 for low): ");
   scanf("%d", &move);

   // Logic to sort the request array (bubble sort)
   for (i = 0; i < n; i++) {
      for (j = 0; j < n - i - 1; j++) {
         if (RQ[j] > RQ[j + 1]) {
            int temp = RQ[j];
            RQ[j] = RQ[j + 1];
            RQ[j + 1] = temp;
         }
      }
   }

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

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

    printf("Total head movement is %d\n", TotalHeadMoment);

    return 0;
}
```

Output:

```
Arugunta hamsika-1BN22Cs054
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 (1 for high, 0 for low): 0
Total head movement is 236
```

(c) C-SCAN

Code:

```
#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: ");
   scanf("%d", &n);

   printf("Enter the Requests sequence: ");
   for (i = 0; i < n; i++)
      scanf("%d", &RQ[i]);

   printf("Enter initial head position: ");
   scanf("%d", &initial);

   printf("Enter total disk size: ");
   scanf("%d", &size);

   printf("Enter the head movement direction (1 for high to low, 0 for low to high): ");
   scanf("%d", &move);

   // Sorting the request array using bubble sort
   for (i = 0; i < n; i++) {
      for (j = 0; j < n - i - 1; j++) {
         if (RQ[j] > RQ[j + 1]) {
            int temp = RQ[j];
            RQ[j] = RQ[j + 1];
            RQ[j + 1] = temp;
         }
      }
   }

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

   // C-SCAN (Circular SCAN) disk scheduling algorithm
   if (move == 1) { // Movement towards high value
      // Service requests from initial index to the end
      for (i = index; i < n; i++) {
         TotalHeadMoment += abs(RQ[i] - initial);
         initial = RQ[i];
      }
```

```
        // Last movement to the end of the disk
        TotalHeadMoment += abs(size - 1 - RQ[i - 1]);
        // Wrap around to the beginning of the disk and service requests
        TotalHeadMoment += abs(size - 1 - 0);
        initial = 0;
        for (i = 0; i < index; i++) {
            TotalHeadMoment += abs(RQ[i] - initial);
            initial = RQ[i];
        }
    } else { // Movement towards low value
        // Service requests from initial index to the beginning
        for (i = index - 1; i >= 0; i--) {
            TotalHeadMoment += abs(RQ[i] - initial);
            initial = RQ[i];
        }
        // Last movement to the beginning of the disk
        TotalHeadMoment += abs(RQ[i + 1] - 0);
        // Wrap around to the end of the disk and service requests
        TotalHeadMoment += abs(size - 1 - 0);
        initial = size - 1;
        for (i = n - 1; i >= index; i--) {
            TotalHeadMoment += abs(RQ[i] - initial);
            initial = RQ[i];
        }
    }

    printf("Total head movement is %d\n", TotalHeadMoment);

    return 0;
}
```

Output:

```
Arugunta hamsika-1BM22CS054
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 (1 for high to low, 0 for low to high): 1
Total head movement is 380
```

```
Arugunta hamsika-1BM22CS054
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 (1 for high to low, 0 for low to high): 0
Total head movement is 384
```