VISVESVARAYA TECHNOLOGICAL UNIVERSITY

"JnanaSangama", Belgaum -590014, Karnataka.

LAB REPORT

on

Operating Systems

(23CS4PCOPS)

Submitted by:

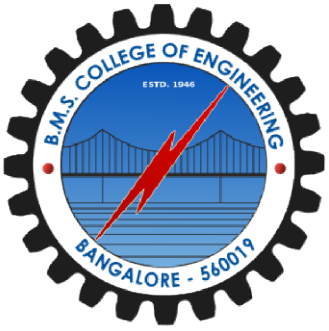
AGNEYA D A (1BM22CS024)

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

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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 **AGNEYA D A (1BM22CS024),** who is bona fide 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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Table Of Contents

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:

```
#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");
    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++) {
        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    Turnaroun
P[1]        0       10      0       10
P[2]        0       1       10      11
```

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    T
P[1]        0       3       0       3
P[2]        1       6       2       8
```

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) 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("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 = 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    T
1               4               2               0               4
2               3               3               4               7
```

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) {
  // 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
5               2               4               5               4
1               4               0               2               0
```

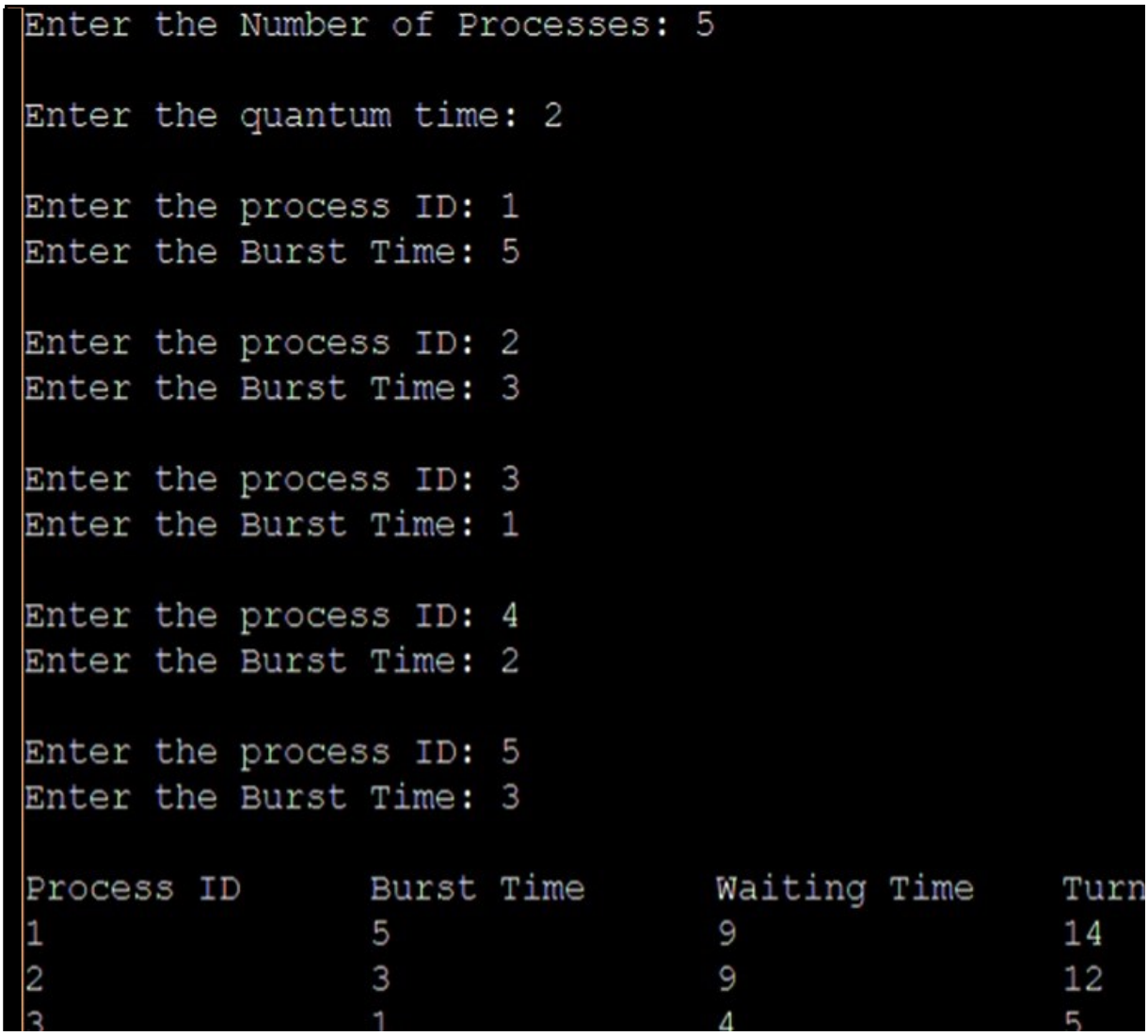
(b) Round Robin (Non-pre-emptive)

```
#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) {
                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:



LAB - 3

Question 1:

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");
   }
}
```

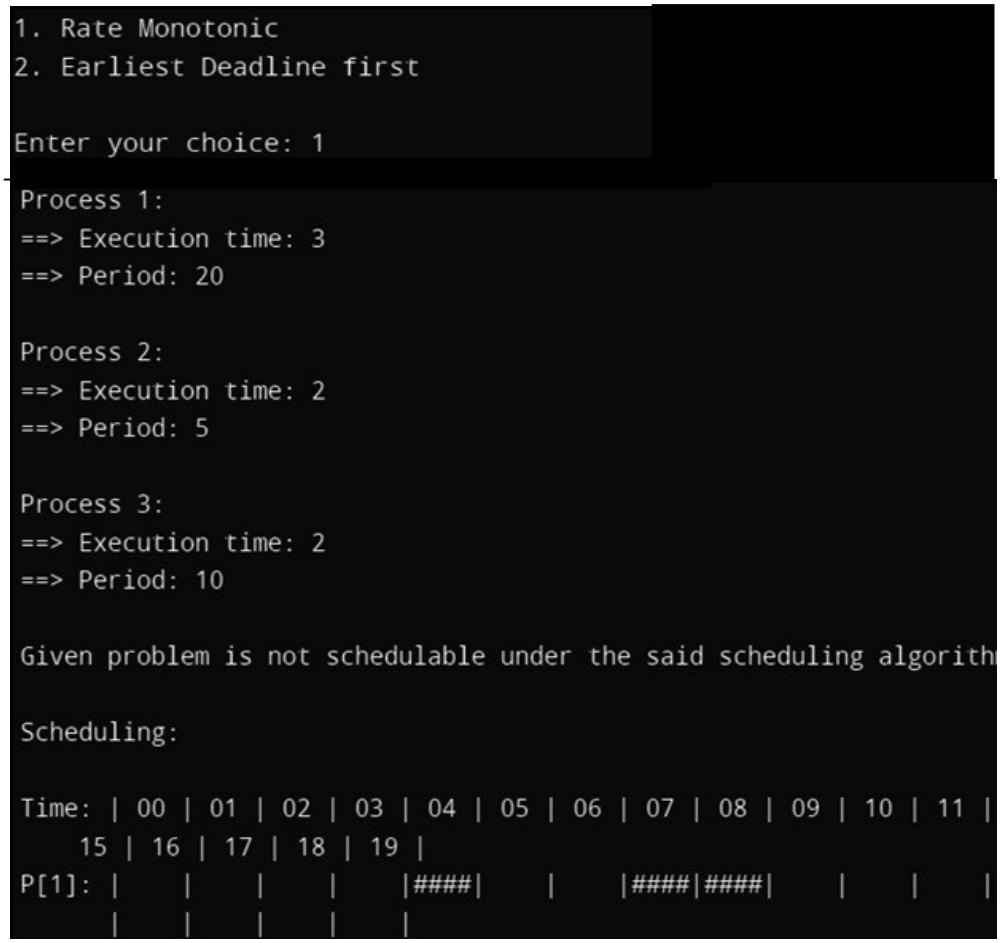
```
void rate_monotonic(int time)
{
   int process_list[100] = {0}, min = 999, next_process = 0;
   float utilization = 0;
   for (int i = 0; i < num_of_process; i++)
   {
      utilization += (1.0 * execution_time[i]) / period[i];
   }
   int n = num_of_process;
   int m = (float) (n * (pow(2, 1.0 / 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];
```

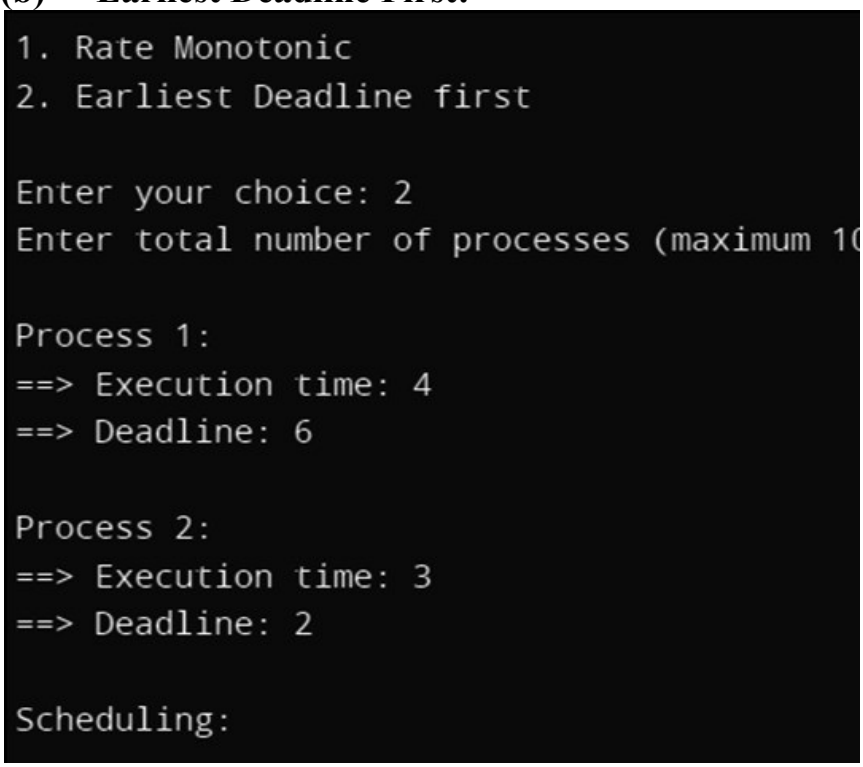
```
            is_ready[i] = true;
        }
    }

    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\\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:



(b) Earliest Deadline First:



LAB - 4

Question 1:
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 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
Enter your choice: 1

Producer produces the item
Enter your choice: 2

Consumer consumes item 2
Enter your choice: 2

Consumer consumes item 1
Enter your choice: 1

Producer produces the item
Enter your choice: 2
```

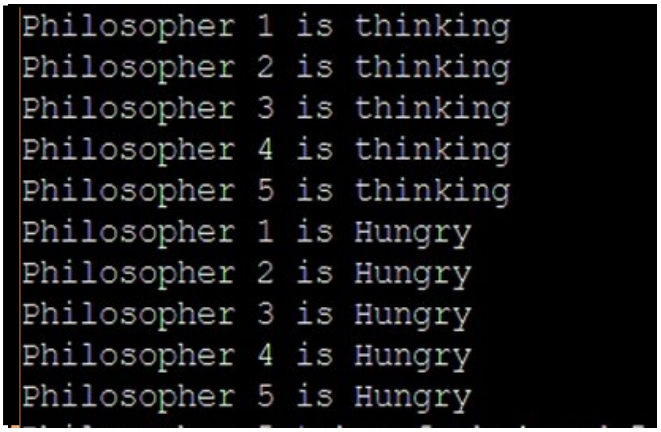
Question 2:
Write a C program to simulate the concept of Dining-Philosophers problem.

CODE:

```
#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;
```

```
        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

LAB 5

Question 1:

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

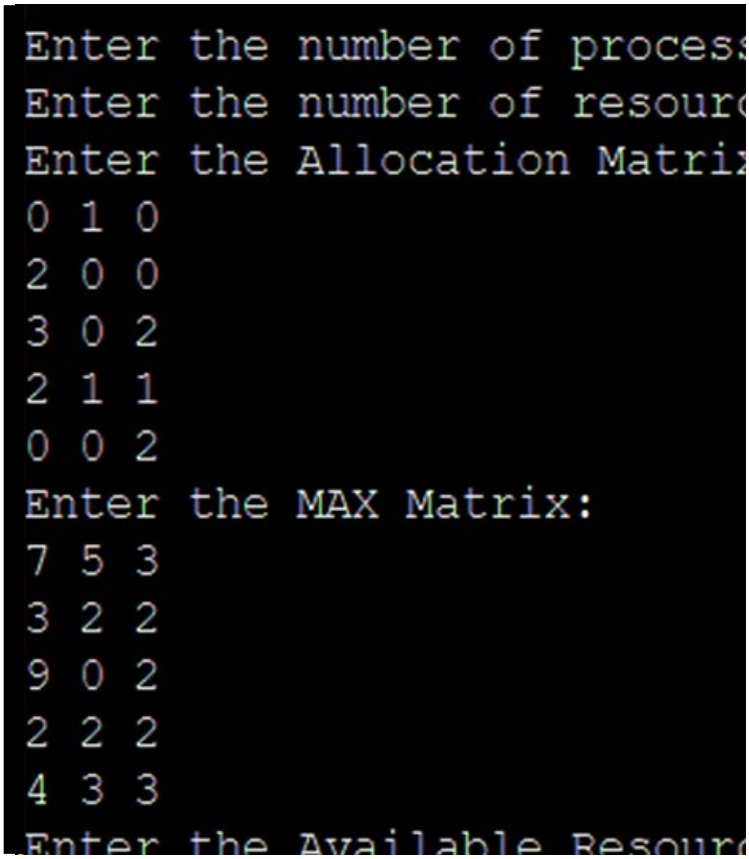
CODE:

```
#include <stdio.h>

int main()
{
   int n, m, i, j, k;
   printf("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 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:



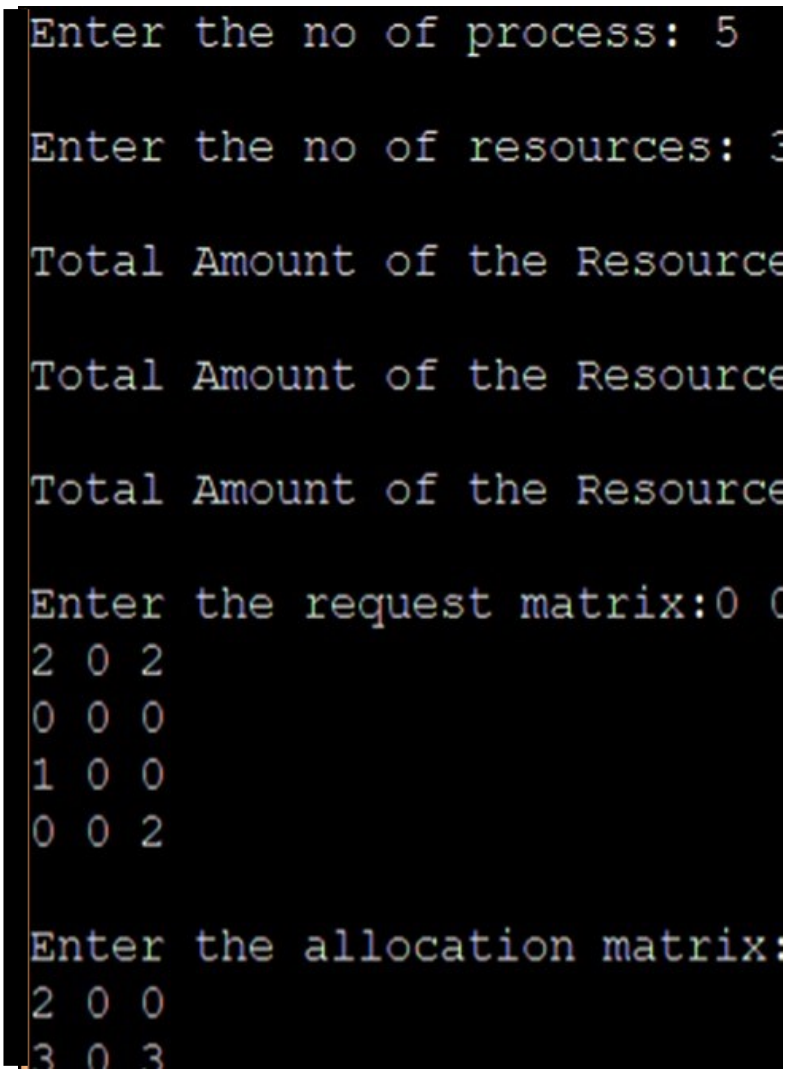
Question 2:
Write a C program to simulate deadlock detection.

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("\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
Total Amount of the Resource
Total Amount of the Resource
Enter the request matrix:0 0
2 0 2
0 0 0
1 0 0
0 0 2
Enter the allocation matrix:
2 0 0
3 0 3

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:

```
#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:

```
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
Memory Management Scheme - First Fit
File_no:        File_size:      Block_no:       Block_size:
1               212             2               500
2               415             5               600
3               63              1               100
4               200             3               200
5               255             4               300

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

Memory Management Scheme - Best Fit
File_no:        File_size:      Block_no:       Block_size:
```

Question 2:
Write a C program to simulate page replacement algorithms:

(a) FIFO

(b) LRU

(c) Optimal

CODE:

```
#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++)
```

```
    {
        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();
```

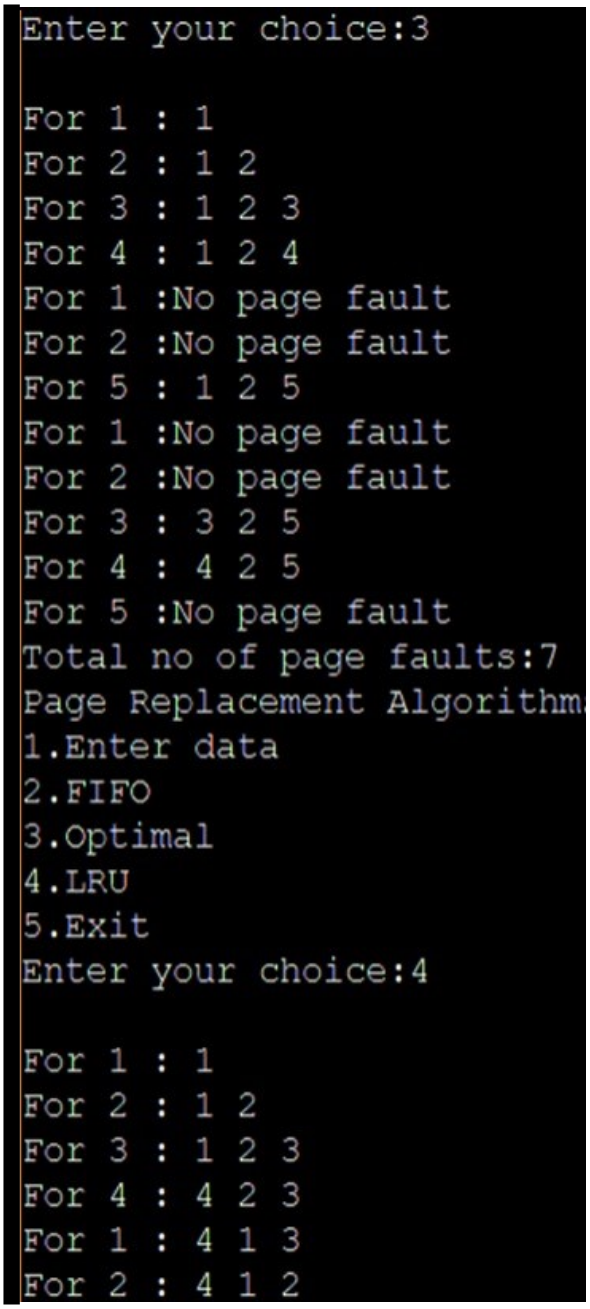
```
    int near[50];
    for(i=0; i<n; i++)
    {

        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();
```

```
    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

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
```


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 Algorithm
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

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
```

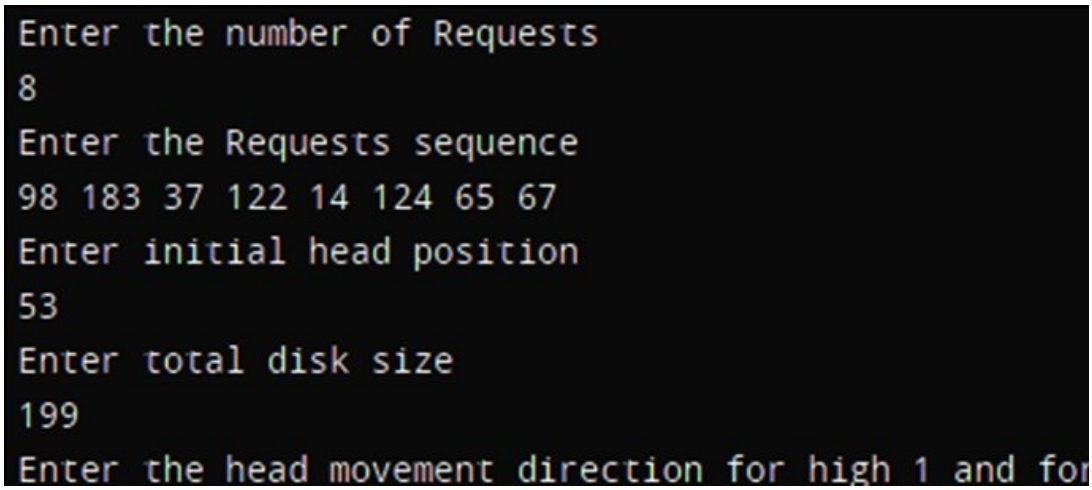
(b)SCAN:

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\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);
        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:



(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\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: