VISVESVARAYA TECHNOLOGICAL UNIVERSITY

"JnanaSangama", Belgaum -590014, Karnataka.

LAB REPORT
on

Operating System

Submitted by

JIGAR D PATEL (1BM21CS081)

in partial fulfillment for the award of the degree of
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in
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B. M. S. College of Engineering,
Bull Temple Road, Bangalore 560019
(Affiliated To Visvesvaraya Technological University, Belgaum)

Department of Computer Science and Engineering

CERTIFICATE

This is to certify that the Lab work entitled "**Operating System**" carried out by **JIGAR D PATEL (1BM21CS081),** 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 academic semester May-2023 to July-2023. The Lab report has been approved as it satisfies the academic requirements in respect of an **Operating System(22CS4PCOPS)** work prescribed for the said degree.

Dr. Prasad G R	**Dr. Jyothi S Nayak**
Professor	Professor and Head
Department of CSE	Department of CSE
BMSCE, Bengaluru	BMSCE, Bengaluru

Course outcome:

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.

Index sheet

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

- **FCFS**
- **SJF (Non-pre-emptive)**

FCFS

```
#include<stdio.h> void
main()
{
   int i,pid[10],n,burst[10],wt[10],ta[10];
float avgwt=0,avgta=0;
   printf("enter the number of processes\n");
scanf("%d",&n);
   printf("enter the process id and it's burst time\n");
for(i=0;i<n;i++)
   {
      scanf("%d",&pid[i]);
scanf("%d",&burst[i]);
   }
   wt[0]=0;
   printf("according first come first serve schedule\n");
for(i=0;i<n;i++)
   {
      printf("processor id %d\t",pid[i]);
printf("burst time %d\n",burst[i]);
   }
   for(i=1;i<n;i++)
   {
      wt[i]=wt[i-1]+burst[i-1];
   }
   for(i=0;i<n;i++)
   {
      ta[i]=wt[i]+burst[i];
   }
   for(i=0;i<n;i++)
```

```
   {
       avgwt+=wt[i];
avgta+=ta[i];
   }
   avgwt=avgwt/n;
avgta=avgta/n;
   printf("\nAverage waiting time is %f\n",avgwt);
printf("\nAverage turnaround time is %f\n",avgta);

}
```

Output:

```
enter the number of processes
4
enter the process id and it's burst time
1 5
2 4
3 3
4 1
according first come first serve schedule
processor id 1  burst time 5
processor id 2  burst time 4
processor id 3  burst time 3
processor id 4  burst time 1

Average waiting time is 6.500000

Average turnaround time is 9.750000
```

SJF(non-pre-emptive)

```
#include<stdio.h> void
swap(int *a,int *b)
{    int
temp;
temp=*a;
   *a=*b;
   *b=temp;
}
void main()
```

```
{
   int i,j,temp,pid[10],n,burst[10],wt[10],ta[10];
float avgwt=0,avgta=0;     printf("enter the
number of processes\n");     scanf("%d",&n);
   printf("enter the process id and it's burst time\n");
for(i=0;i<n;i++)
   {
      scanf("%d",&pid[i]);
scanf("%d",&burst[i]);
   }
   //sorting     for(i=0;i<n-
1;i++)
   {        for(j=0;j<n-i-
1;j++)
      {
         if(burst[j]>burst[j+1])
         {
            swap(&burst[j],&burst[j+1]);
swap(&pid[j],&pid[j+1]);
         }
      }
   }
   printf("according shortest job schedule\n");
for(i=0;i<n;i++)
   {
      printf("processor id %d\t",pid[i]);
printf("burst time %d\n",burst[i]);
   }
   wt[0]=0;
for(i=1;i<n;i++)
   {
      wt[i]=wt[i-1]+burst[i-1];
   }
   for(i=0;i<n;i++)
```

```
    {
        ta[i]=wt[i]+burst[i];
    }
    for(i=0;i<n;i++)
    {
        avgwt+=wt[i];
avgta+=ta[i];
    }
    avgwt=avgwt/n;
avgta=avgta/n;
    printf("\nAverage waiting time is %f\n",avgwt);
printf("\nAverage turnaround time is %f\n",avgta);


}
```

Output:

```
enter the number of processes

4
enter the process id and it's burst time
1 2
2 5
3 1
4 4
according shortest job schedule
processor id 3  burst time 1
processor id 1  burst time 2
processor id 4  burst time 4
processor id 2  burst time 5

Average waiting time is 2.750000

Average turnaround time is 5.750000
```

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

- **SJF (pre-emptive)**
- **Priority (pre-emptive & Non-pre-emptive)**
- **Round Robin (Experiment with different quantum sizes for RR algorithm)**

```
#include <stdio.h>

#include <stdbool.h>


#define MAX_PROCESSES 10


struct Process

{    int pid;    int

arrival_time;    int

burst_time;    int

priority;    int

remaining_time;    int

turnaround_time;    int

waiting_time;

};


void sjf_preemptive(struct Process processes[], int n)

{

   int total_time = 0, i;

int completed = 0;


   while (completed < n)

   {

      int shortest_burst = -1;

int next_process = -1;


      for (i = 0; i < n; i++)

      {

         if (processes[i].arrival_time <= total_time && processes[i].remaining_time > 0)

         {
```

```
                if (shortest_burst == -1 || processes[i].remaining_time < shortest_burst)
                {
                    shortest_burst = processes[i].remaining_time;
next_process = i;
                }
            }
        }

        if (next_process == -1)
        {
            total_time++;
continue;
        }

        processes[next_process].remaining_time--;
total_time++;

        if (processes[next_process].remaining_time == 0)
        {
            completed++;
            processes[next_process].turnaround_time = total_time - 
processes[next_process].arrival_time;
            processes[next_process].waiting_time = processes[next_process].turnaround_time - 
processes[next_process].burst_time;
        }
    }

    double total_turnaround_time = 0;
double total_waiting_time = 0;

    printf("Process\tTurnaround Time\tWaiting Time\n");
```

```
    for (i = 0; i < n; i++)
    {
        printf("%d\t%d\t\t%d\n", processes[i].pid, processes[i].turnaround_time,
processes[i].waiting_time);

        total_turnaround_time += processes[i].turnaround_time;
total_waiting_time += processes[i].waiting_time;
    }

    printf("Average Turnaround Time: %.2f\n", total_turnaround_time / n);
printf("Average Waiting Time: %.2f\n", total_waiting_time / n);
}

void priority_nonpreemptive(struct Process processes[], int n)
{
    int i, j, count = 0, m;
for (i = 0; i < n; i++)
    {
        if (processes[i].arrival_time == 0)
count++;
    }
    if (count == n || count == 1)
    {
        if (count == n)
        {
            for (i = 0; i < n - 1; i++)
            {
                for (j = 0; j < n - i - 1; j++)
                {
                    if (processes[j].priority > processes[j + 1].priority)
                    {
                        struct Process temp = processes[j];
processes[j] = processes[j + 1];                    processes[j + 1]
= temp;
```

```
                    }
                }
            }
        }
else
{
            for (i = 1; i < n - 1; i++)
            {
                for (j = 1; j <= n - i - 1; j++)
                {
                    if (processes[j].priority > processes[j + 1].priority)
                    {
                        struct Process temp = processes[j];
processes[j] = processes[j + 1];                         processes[j
+ 1] = temp;
                    }
                }
            }
        }
    }

    int total_time = 0;
    double total_turnaround_time = 0;
double total_waiting_time = 0;

    for (i = 0; i < n; i++)
    {
        total_time += processes[i].burst_time;
        processes[i].turnaround_time = total_time - processes[i].arrival_time;
```

```
        processes[i].waiting_time = processes[i].turnaround_time - processes[i].burst_time;
total_turnaround_time += processes[i].turnaround_time;                total_waiting_time +=
processes[i].waiting_time;
    }

    printf("Process\tTurnaround Time\tWaiting Time\n");
for (i = 0; i < n; i++)
    {
        printf("%d\t%d\t\t%d\n", processes[i].pid, processes[i].turnaround_time,
processes[i].waiting_time);
    }

    printf("Average Turnaround Time: %.2f\n", total_turnaround_time / n);
printf("Average Waiting Time: %.2f\n", total_waiting_time / n);
}

void priority_preemptive(struct Process processes[], int n)
{
    int total_time = 0, i;
int completed = 0;

    while (completed < n)
    {
        int highest_priority = -1;
int next_process = -1;

        for (i = 0; i < n; i++)
        {
            if (processes[i].arrival_time <= total_time && processes[i].remaining_time > 0)
            {
                if (highest_priority == -1 || processes[i].priority <
highest_priority)
                {
                    highest_priority = processes[i].priority;
```

```
                    next_process = i;
                }
            }
        }

        if (next_process == -1)
        {
            total_time++;
continue;
        }

        processes[next_process].remaining_time--;
total_time++;

        if (processes[next_process].remaining_time == 0)
        {
            completed++;
            processes[next_process].turnaround_time = total_time -
processes[next_process].arrival_time;
            processes[next_process].waiting_time = processes[next_process].turnaround_time -
processes[next_process].burst_time;
        }
    }

    double total_turnaround_time = 0;
double total_waiting_time = 0;

    printf("Process\tTurnaround Time\tWaiting Time\n");
for (i = 0; i < n; i++)
    {
        printf("%d\t%d\t\t%d\n", processes[i].pid, processes[i].turnaround_time,
processes[i].waiting_time);
```

```
        total_turnaround_time += processes[i].turnaround_time;
total_waiting_time += processes[i].waiting_time;
    }

    printf("Average Turnaround Time: %.2f\n", total_turnaround_time / n);
printf("Average Waiting Time: %.2f\n", total_waiting_time / n);
}

void round_robin(struct Process processes[], int n, int quantum)
{
    int total_time = 0, i;
int completed = 0;

    while (completed < n)
    {
        for (i = 0; i < n; i++)
        {
            if (processes[i].arrival_time <= total_time && processes[i].remaining_time > 0)
            {
                if (processes[i].remaining_time <= quantum)
                {
                    total_time += processes[i].remaining_time;
processes[i].remaining_time = 0;
                    processes[i].turnaround_time = total_time - processes[i].arrival_time;
processes[i].waiting_time = processes[i].turnaround_time -
processes[i].burst_time;                    completed++;
                }
else
                {
                    total_time += quantum;
                    processes[i].remaining_time -= quantum;
                }
            }
```

```
        }
    }

    double total_turnaround_time = 0;
double total_waiting_time = 0;

    printf("Process\tTurnaround Time\tWaiting Time\n");
for (i = 0; i < n; i++)
    {
        printf("%d\t%d\t\t%d\n", processes[i].pid, processes[i].turnaround_time,
processes[i].waiting_time);

        total_turnaround_time += processes[i].turnaround_time;
total_waiting_time += processes[i].waiting_time;
    }

    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, i, choice;
    struct Process processes[MAX_PROCESSES];

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

    for (i = 0; i < n; i++)
    {
```

```
        printf("Process %d\n", i + 1);
printf("Enter arrival time: ");         scanf("%d",
&processes[i].arrival_time);         printf("Enter
burst time: ");         scanf("%d",
&processes[i].burst_time);         printf("Enter
priority: ");         scanf("%d",
&processes[i].priority);         processes[i].pid =
i + 1;
        processes[i].remaining_time = processes[i].burst_time;
processes[i].turnaround_time = 0;         processes[i].waiting_time
= 0;
    }

    printf("Select a scheduling algorithm:\n");
printf("1. SJF Preemptive\n");     printf("2.
Priority Non-preemptive\n");     printf("3.
Priority Preemptive\n");     printf("4. Round
Robin\n");     printf("Enter your choice: ");
scanf("%d", &choice);

    switch (choice)
    {
    case 1:
        printf("\nSJF Preemptive Scheduling:\n");
sjf_preemptive(processes,  n);                break;
case 2:
        printf("\nPriority Non-preemptive Scheduling:\n");
priority_nonpreemptive(processes, n);         break;
case 3:
        printf("\nPriority Preemptive Scheduling:\n");
priority_preemptive(processes, n);

        break;
case 4:
```

```
        printf("\nEnter the quantum size for Round Robin: ");
scanf("%d", &quantum);
        printf("\nRound Robin Scheduling (Quantum: %d):\n", quantum);
round_robin(processes, n, quantum);          break;     default:
printf("Invalid choice!\n");          return 1;
    }


    return 0;
}
```

Output:

```
Enter the number of processes: 3
Process 1
Enter arrival time: 0
Enter burst time: 3
Enter priority: 2
Process 2
Enter arrival time: 1
Enter burst time: 4
Enter priority: 3
Process 3
Enter arrival time: 2
Enter burst time: 5
Enter priority: 3
Select a scheduling algorithm:
1. SJF Preemptive
2. Priority Non-preemptive
3. Priority Preemptive
4. Round Robin
Enter your choice: 1

SJF Preemptive Scheduling:
Process Turnaround Time Waiting Time
1       3               0
2       6               2
3       10              5
Average Turnaround Time: 6.33
Average Waiting Time: 2.33
```

```
Enter the number of processes: 3
Process 1
Enter arrival time: 0
Enter burst time: 2
Enter priority: 2
Process 2
Enter arrival time: 1
Enter burst time: 6
Enter priority: 3
Process 3
Enter arrival time: 2
Enter burst time: 4
Enter priority: 2
Select a scheduling algorithm:
1. SJF Preemptive
2. Priority Non-preemptive
3. Priority Preemptive
4. Round Robin
Enter your choice: 2

Priority Non-preemptive Scheduling:
Process Turnaround Time Waiting Time
1       2               0
3       4               0
2       11              5
Average Turnaround Time: 5.67
Average Waiting Time: 1.67
```

```
Enter the number of processes: 3
Process 1
Enter arrival time: 0
Enter burst time: 2
Enter priority: 0
Process 2
Enter arrival time: 1
Enter burst time: 5
Enter priority: 3
Process 3
Enter arrival time: 2
Enter burst time: 4
Enter priority: 2
Select a scheduling algorithm:
1. SJF Preemptive
2. Priority Non-preemptive
3. Priority Preemptive
4. Round Robin
Enter your choice: 3

Priority Preemptive Scheduling:
Process Turnaround Time Waiting Time
1       2               0
2       10              5
3       4               0
Average Turnaround Time: 5.33
Average Waiting Time: 1.67
```

```
Enter the number of processes: 3
Process 1
Enter arrival time: 0
Enter burst time: 1
Enter priority: 2
Process 2
Enter arrival time: 1
Enter burst time: 5
Enter priority: 3
Process 3
Enter arrival time: 2
Enter burst time: 4
Enter priority: 2
Select a scheduling algorithm:
1. SJF Preemptive
2. Priority Non-preemptive
3. Priority Preemptive
4. Round Robin
Enter your choice: 4

Enter the quantum size for Round Robin: 2

Round Robin Scheduling (Quantum: 2):
Process Turnaround Time Waiting Time
1       1               0
2       9               4
3       7               3
Average Turnaround Time: 5.67
Average Waiting Time: 2.33
```

3. 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.

```
#include<stdio.h> void
swap(int *a,int *b)
{    int
temp;
temp=*a;
   *a=*b;
   *b=temp;
}
void main()
{
   int n,pid[10],burst[10],type[10],arr[10],wt[10],ta[10],ct[10],i,j;
float avgwt=0,avgta=0;     int sum = 0;
   printf("Enter the total number of processes\n");
scanf("%d",&n);     for(i=0;i<n;i++)
   {
      printf("Enter the process id, type of process(user-0 and system-1), arrival time and
burst time\n");        scanf("%d",&pid[i]);        scanf("%d",&type[i]);
scanf("%d",&arr[i]);        scanf("%d",&burst[i]);
   }
   //sorting the processes according to arrival time     for(i=0;i<n-
1;i++)
   {
      for(j=0;j<n-i-1;j++)
      {
         if(arr[j]>arr[j+1])
         {
            swap(&arr[j],&arr[j+1]);
swap(&pid[j],&pid[j+1]);
swap(&burst[j],&burst[j+1]);
swap(&type[j],&type[j+1]);
```

```
        }
      }
    }
    //assuming only two process can have same arrival time and different priority
for(i=0;i<n-1;i++)
    {
      for(j=0;j<n-i-1;j++)
      {
        if(arr[j]==arr[j+1] && type[j]<type[j+1])
        {
          swap(&arr[j],&arr[j+1]);
swap(&pid[j],&pid[j+1]);
swap(&burst[j],&burst[j+1]);
swap(&type[j],&type[j+1]);
        }
      }
    }
    //calculating completion time, arrival time and waiting time
sum = sum + arr[0];     for(i = 0;i<n;i++){         sum = sum +
burst[i];         ct[i] = sum;         ta[i] = ct[i] - arr[i];         wt[i] =
ta[i] - burst[i];          if(sum<arr[i+1]){            int t = arr[i+1]-
sum;
        sum = sum+t;
      }
    }

    printf("Process id\tType\tarrival time\tburst time\twaiting time\tturnaround time\n");
for(i=0;i<n;i++)
    {
```

```c
        avgta+=ta[i];
avgwt+=wt[i];
        printf("%d\t\t%d\t\t%d\t\t%d\t\t%d\t\t%d\n",pid[i],type[i],arr[i],burst[i],wt[i],ta[i]);
    }
    printf("average waiting time =%f\n",avgwt/n);
printf("average turnaround time =%f",avgta/n);


}
```

Output:

```
Enter the total number of processes
4
Enter the process id, type of process(user-0 and system-1), arrival time and burst time
1 0 0 5
Enter the process id, type of process(user-0 and system-1), arrival time and burst time
2 1 0 4
Enter the process id, type of process(user-0 and system-1), arrival time and burst time
3 0 2 5
Enter the process id, type of process(user-0 and system-1), arrival time and burst time
4 1 4 3
Process id      Type    arrival time    burst time      waiting time    turnaround time
2               1               0               4               0               4
1               0               0               5               4               9
3               0               2               5               7               12
4               1               4               3               10              13
average waiting time =5.250000
average turnaround time =9.500000
```

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

a) Rate- Monotonic

b) Earliest-deadline First

c) Proportional scheduling

```c
#include <stdio.h>
#include <stdlib.h>
#include <math.h>
#include <stdbool.h>
#define MAX_PROCESS 10
```

```
int num_of_process = 3, count, remain, time_quantum; int
execution_time[MAX_PROCESS], period[MAX_PROCESS],
remain_time[MAX_PROCESS], deadline[MAX_PROCESS],
remain_deadline[MAX_PROCESS];
int burst_time[MAX_PROCESS], wait_time[MAX_PROCESS],
completion_time[MAX_PROCESS], arrival_time[MAX_PROCESS];
// collecting details of processes 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)
   {
      printf("Do you really want to schedule %d processes? -_-",
num_of_process);    exit(0);
   }
   for (int i = 0; i < num_of_process; i++)
   {
      printf("\nProcess %d:\n", i + 1);
printf("==> Execution time: "); scanf("%d",
&execution_time[i]);

      remain_time[i] = execution_time[i];


      printf("==> Period: ");
scanf("%d", &period[i]);
   }
}
// get maximum of three numbers 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;
}
// calculating the observation time for scheduling timeline int
get_observation_time(int selected_algo)
{

    return max(period[0], period[1], period[2]);
}
// print scheduling sequence 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;
    if (utilization > n * (pow(2, 1.0 / n) - 1))
    {
        printf("\nGiven problem is not schedulable under the said scheduling algorithm.\n");
exit(0);
    }
    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; // +1 for catering 0 array index.
            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);
}
int main(int argc, char *argv[])
{
    int option = 0;
    printf("3. Rate Monotonic Scheduling\n");
printf("Select > ");     scanf("%d", &option);
    printf("-----------------------------\n");
    get_process_info(option); // collecting processes detail
int observation_time = get_observation_time(option);     if
(option == 3)
        rate_monotonic(observation_time);
return 0;
}
```

Output:

```
3. Rate Monotonic Scheduling
Select > 3
-----------------------------
Enter total number of processes (maximum 10): 3

Process 1:
==> Execution time: 2
==> Period: 5

Process 2:
==> Execution time: 1
==> Period: 10

Process 3:
==> Execution time: 3
==> Period: 15

Scheduling:

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

```
#include <stdio.h>
#define arrival          0
#define execution        1
#define deadline         2
#define period           3
#define abs_arrival            4
    #define execution_copy  5
    #define abs_deadline 6


    typedef struct
    {
        int T[7],instance,alive;

    }task;

    #define IDLE_TASK_ID 1023
    #define ALL 1
    #define CURRENT 0

    void get_tasks(task *t1,int n);          int hyperperiod_calc(task *t1,int n);
    float cpu_util(task *t1,int n);          int gcd(int a, int b);
       int lcm(int *a, int n);                   int sp_interrupt(task *t1,int
    tmr,int n);    int min(task *t1,int n,int p);
    void update_abs_arrival(task *t1,int n,int k,int all); void update_abs_deadline(task
    *t1,int n,int all); void copy_execution_time(task *t1,int n,int all);


    int timer = 0;

    int main()
```

```
int n, hyper_period, active_task_id;
float cpu_utilization; printf("Enter
number of tasks\n"); scanf("%d",
&n);
t = malloc(n * sizeof(task));    get_tasks(t, n);
cpu_utilization = cpu_util(t, n);         printf("CPU
Utilization %f\n", cpu_utilization);

if (cpu_utilization < 1)
printf("Tasks can be scheduled\n");
else
        printf("Schedule is not feasible\n");

hyper_period = hyperperiod_calc(t, n);
copy_execution_time(t, n, ALL);       update_abs_arrival(t, n,
0, ALL);          update_abs_deadline(t, n, ALL);

while (timer <= hyper_period)
{

        if (sp_interrupt(t, timer, n))
        {
                active_task_id = min(t, n, abs_deadline);
        }

        if (active_task_id == IDLE_TASK_ID)
        {
                printf("%d  Idle\n", timer);
        }

        if (active_task_id != IDLE_TASK_ID)
```

```
                {

                        if (t[active_task_id].T[execution_copy] != 0)
                        {
                                t[active_task_id].T[execution_copy]--;
                printf("%d  Task %d\n", timer, active_task_id + 1);
                        }

                        if (t[active_task_id].T[execution_copy] == 0)
                        {
                                t[active_task_id].instance++;
                t[active_task_id].alive = 0;
                                copy_execution_time(t, active_task_id, CURRENT);
                                update_abs_arrival(t, active_task_id,
t[active_task_id].instance, CURRENT);
   update_abs_deadline(t, active_task_id, CURRENT);     active_task_id = min(t, n,
abs_deadline);
                        }
        }
                ++timer;
        }
        free(t);
return 0;
}
void get_tasks(task *t1, int n)
{
        int i = 0;
while (i < n)
        {
  printf("Enter Task %d parameters\n", i + 1);   printf("Arrival
time:       ");                    scanf("%d",       &t1->T[arrival]);
printf("Execution time: ");       scanf("%d",                  &t1-
>T[execution]);          printf("Deadline         time:          ");
scanf("%d", &t1->T[deadline]);
```

```
                    printf("Period: ");
scanf("%d", &t1->T[period]);              t1-
>T[abs_arrival] = 0;              t1-
>T[execution_copy] = 0;                   t1-
>T[abs_deadline] = 0;                     t1-
>instance = 0;                    t1->alive = 0;
                    t1++;
          i++;      }
}

int hyperperiod_calc(task *t1, int n)
{
          int i = 0, ht, a[10];
while (i < n)

          {
                    a[i] = t1->T[period];
          t1++;               i++;
          }
          ht = lcm(a, n);

          return ht;
}

int gcd(int a, int b)
{
          if (b == 0)
                    return a;
else
                    return gcd(b, a % b);
```

```
}

int lcm(int *a, int n)
{
        int res = 1, i;    for
(i = 0; i < n; i++)
        {
                res = res * a[i] / gcd(res, a[i]);
        }
        return res;
}

int sp_interrupt(task *t1, int tmr, int n)
{
        int i = 0, n1 = 0, a = 0;
task *t1_copy;
t1_copy = t1;   while (i < n)
        {
                if (tmr == t1->T[abs_arrival])
                {
                        t1->alive = 1;
                        a++;
                }
                t1++;
                i++;
        }
        t1 = t1_copy; i
        = 0;

        while (i < n)
        {
                if (t1->alive == 0)
```

```
                n1++;
        t1++;       i++;
        }

        if (n1 == n || a != 0)
        {
            return 1;
        }

        return 0;
}

void update_abs_deadline(task *t1, int n, int all)
{
        int i = 0;
if (all)
        {
            while (i < n)
            {
                t1->T[abs_deadline] = t1->T[deadline] + t1->T[abs_arrival];
            t1++;       i++;
            }
        }
        else
        {
            t1 += n;
            t1->T[abs_deadline] = t1->T[deadline] + t1->T[abs_arrival];
        }
}
```

```
void update_abs_arrival(task *t1, int n, int k, int all)
{
	int i = 0;
if (all)
	{
		while (i < n)
		{
			t1->T[abs_arrival] = t1->T[arrival] + k * (t1->T[period]);
			t1++;
	i++;
		}
	}
	else
	{
		t1 += n;
		t1->T[abs_arrival] = t1->T[arrival] + k * (t1->T[period]);
	}
}

void copy_execution_time(task *t1, int n, int all)
{
	int i = 0;
	if (all)
	{
		while (i < n)
		{
			t1->T[execution_copy] = t1->T[execution];
			t1++;
		i++;
		}
	}
	else
	{
```

```
                t1 += n;
                t1->T[execution_copy] = t1->T[execution];
        }
}

int min(task *t1, int n, int p)
{
        int i = 0, min = 0x7FFF, task_id = IDLE_TASK_ID;
while (i < n)
        {
                if (min > t1->T[p] && t1->alive == 1)
                {
                        min = t1->T[p];
        task_id = i;
                }
                t1++;
i++;
        }
        return task_id;
}

float cpu_util(task *t1, int n)
{ int i = 0;
        float cu = 0; while
        (i < n)
        {
                cu = cu + (float)t1->T[execution] / (float)t1->T[deadline];
                t1++;
i++;
        }
```

```
        return cu;
}

#include <stdio.h>
#include <stdlib.h>
#include <time.h>
#define  n  3  int
main() {

   srand(time(0));

   int numbers[n];
   int i;
      for (i = 0; i < n; i++) {
numbers[i] = rand() % 10 + 1;
   }

   printf("Initial  Numbers:  ");
for  (i  =  0;  i  <  n;  i++)  {
printf("%d ", numbers[i]);
   }
printf("\n");

   while (1) {

      int    all_zero    =    1;
for (i = 0; i < n; i++) {         if
(numbers[i]     >     0)     {
all_zero = 0;             break;
         }
      }        if
(all_zero) {
break;
      }
```

```
        int selected_index;
do {
            selected_index = rand() % n;
        } while (numbers[selected_index] == 0);
numbers[selected_index]--;
        printf("Decrementing number at index %d: ", selected_index);
for (i = 0; i < n; i++) {            printf("%d ", numbers[i]);
        }
printf("\n");
    }

    printf("All numbers reached 0.\n");

    return 0;
}
```

Output:

```
Initial Numbers: 5 7 10
Decrementing number at index 1: 5 6 10
Decrementing number at index 0: 4 6 10
Decrementing number at index 2: 4 6 9
Decrementing number at index 0: 3 6 9
Decrementing number at index 0: 2 6 9
Decrementing number at index 0: 1 6 9
Decrementing number at index 1: 1 5 9
Decrementing number at index 2: 1 5 8
Decrementing number at index 1: 1 4 8
Decrementing number at index 0: 0 4 8
Decrementing number at index 2: 0 4 7
Decrementing number at index 1: 0 3 7
Decrementing number at index 1: 0 2 7
Decrementing number at index 2: 0 2 6
Decrementing number at index 1: 0 1 6
Decrementing number at index 1: 0 0 6
Decrementing number at index 2: 0 0 5
Decrementing number at index 2: 0 0 4
Decrementing number at index 2: 0 0 3
Decrementing number at index 2: 0 0 2
Decrementing number at index 2: 0 0 1
Decrementing number at index 2: 0 0 0
All numbers reached 0.
```

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

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

#define BUFFER_SIZE 10
#define NUM_ITEMS 20

int buffer[BUFFER_SIZE];
int fill = 0; // Index to add data by producer int use
= 0; // Index to consume data by consumer int
count = 0; // Number of items in the buffer

sem_t empty; // Semaphore to track empty slots in the buffer
sem_t full; // Semaphore to track the number of items available for consumption

void put(int value) {     buffer[fill] =
value;     fill = (fill + 1) %
BUFFER_SIZE;     count++;
}

int get() {
   int tmp = buffer[use];     use = (use
+ 1) % BUFFER_SIZE;
   count--;
return tmp;
}

void *producer(void *arg) {
```

```
    int i;
    for (i = 0; i < NUM_ITEMS; i++) {
        sem_wait(&empty); // Wait for an empty slot
put(i);
        printf("Produced: %d\n", i);
        sem_post(&full); // Signal that an item is produced
    }
    pthread_exit(NULL);
}

void *consumer(void *arg) {
    int i;
    for (i = 0; i < NUM_ITEMS; i++) {
        sem_wait(&full); // Wait for an item to be produced
int value = get();
        printf("Consumed: %d\n", value);
        sem_post(&empty); // Signal that an empty slot is available
    }
    pthread_exit(NULL);
}

int main() {
    // Initialize semaphores
    sem_init(&empty, 0, BUFFER_SIZE); // Set empty slots to BUFFER_SIZE
sem_init(&full, 0, 0); // No items available initially

    pthread_t producer_thread, consumer_thread;

    // Create threads
```

```
    pthread_create(&producer_thread, NULL, producer, NULL);
pthread_create(&consumer_thread, NULL, consumer, NULL);

    // Wait for threads to finish
pthread_join(producer_thread, NULL);
pthread_join(consumer_thread, NULL);


    // Destroy semaphores
sem_destroy(&empty);
sem_destroy(&full);

    return 0;
}
```

Output:

```
Produced: 0
Produced: 1
Produced: 2
Produced: 3
Produced: 4
Produced: 5
Produced: 6
Consumed: 0
Produced: 7
Produced: 8
Produced: 9
Produced: 10
Consumed: 1
Consumed: 2
Consumed: 3
Produced: 11
Produced: 12
Produced: 13
Consumed: 4
Consumed: 5
Consumed: 6
Consumed: 7
Consumed: 8
Consumed: 9
Consumed: 10
Consumed: 11
Consumed: 12
Consumed: 13
Produced: 14
Produced: 15
Consumed: 14
Produced: 16
Produced: 17
Produced: 18
Produced: 19
Consumed: 15
Consumed: 16
Consumed: 17
Consumed: 18
Consumed: 19
```

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

```
#include <pthread.h>

#include <semaphore.h>

#include <stdio.h>


#define N 5

#define THINKING 2

#define HUNGRY 1
```

```
#define EATING 0
#define LEFT (phnum + 4) % N
#define RIGHT (phnum + 1) % N

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

sem_t mutex; sem_t
S[N];

void test(int phnum)
{
   if (state[phnum] == HUNGRY && state[LEFT] != EATING && state[RIGHT] != EATING)
   {
      // state that eating
state[phnum] = EATING;

      sleep(2);

      printf("Philosopher %d takes fork %d and %d\n",
phnum + 1, LEFT + 1, phnum + 1);

      printf("Philosopher %d is Eating\n", phnum + 1);

      // sem_post(&S[phnum]) has no effect
      // during takefork
      // used to wake up hungry philosophers
      // during putfork
sem_post(&S[phnum]);
   }
}

// take up chopsticks void
take_fork(int phnum)
```

```
{

    sem_wait(&mutex);

    // state that hungry
state[phnum] = HUNGRY;

    printf("Philosopher %d is Hungry\n", phnum + 1);

    // eat if neighbours are not eating
test(phnum);

    sem_post(&mutex);

    // if unable to eat wait to be signalled
sem_wait(&S[phnum]);

    sleep(1);
}

// put down chopsticks void
put_fork(int phnum) {

    sem_wait(&mutex);

    // state that thinking
state[phnum] = THINKING;
```

```
    printf("Philosopher %d putting fork %d and %d down\n",
phnum + 1, LEFT + 1, phnum + 1);      printf("Philosopher
%d is thinking\n", phnum + 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];
```

```
    // initialize the semaphores
sem_init(&mutex, 0, 1);

    for (i = 0; i < N; i++)

        sem_init(&S[i], 0, 0);

    for (i = 0; i < N; i++)
    {

        //    create    philosopher    processes
pthread_create(&thread_id[i],         NULL,
philosopher, &phil[i]);

        printf("Philosopher %d is thinking\n", i + 1);
    }

    for (i = 0; i < N; i++)

        pthread_join(thread_id[i], NULL);
}
```

Output:

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

7. Write a C program to simulate Bankers algorithm for the purpose of deadlock avoidance. #include <stdio.h> int main()

```
{
   int n, m, all[10][10], req[10][10], ava[10], need[10][10];
int i, j, k, flag[10], prev[10], c, count = 0, array[10], z = 0;
   printf("Enter number of processes and number of resources required \n");
scanf("%d %d", &n, &m);
   printf("Enter the max matrix for all process\n", n);
for (i = 0; i < n; i++)         for (j = 0; j < m; j++)
scanf("%d", &req[i][j]);
   printf("Enter number of allocated resources %d for each process\n", n);
for (i = 0; i < n; i++)         for (j = 0; j < m; j++)            scanf("%d", &all[i][j]);
   printf("Enter number of available resources \n");
for (i = 0; i < m; i++)         scanf("%d", &ava[i]);
for (i = 0; i < n; i++)         for (j = 0; j < m; j++)
need[i][j] = req[i][j] - all[i][j];     for (i = 0; i < n; i++)
flag[i] = 1;     k = 1;     while (k)
   {
      k = 0; // Reset the value of k for each iteration of the loop
for (i = 0; i < n; i++)
      {
         if (flag[i])
         {
            c = 0;
            for (j = 0; j < m; j++)
            {
               if (need[i][j] <= ava[j])
               {
c++;
```

```
                    }
}                 if (c ==
m)
                {
                    array[z++] = i;
                    printf("Resouces can be allocated to Process:%d and available resources are: ",
(i
                                                                                    + 1));

                    for (j = 0; j < m; j++)
                    {
                        printf("%d ", ava[j]);
                    }
                    printf("\n");
for (j = 0; j < m; j++)
                    {
                        ava[j] += all[i][j];
all[i][j] = 0;
                    }
flag[i] = 0;
count++;
                }
            }
        }
        // Check if the current state is different from the previous state
for (i = 0; i < n; i++)
        {
            if (flag[i] != prev[i])
            {
k = 1;
break;
```

```
            }
}
        for (i = 0; i < n; i++)
        {
            prev[i] = flag[i];
        }
    }
    printf("\nNeed Matrix:\n");     for (i = 0; i <
n; i++) // printing need matrix
    {
        for  (j  =  0;  j  <  m;  j++)
printf("%d       ",       need[i][j]);
printf("\n");
    }

    if (count == n)
    {
        printf("\nSystem is in safe mode \n<");
for (i = 0; i < n; i++)               printf("P%d ",
(array[i] + 1));         printf(">\n");
    }
else
    {
        printf("\nSystem is not in safe mode deadlock occurred \n");
    }
    return 0;
}
```

Output:

```
Enter number of processes and number of resources required
5 3
Enter the max matrix for all process
7 5 3
3 2 2
9 0 2
2 2 2
4 3 3
Enter number of allocated resources 5 for each process
0 1 0
2 0 0
3 0 2
2 1 1
0 0 2
Enter number of available resources
3 3 2
Resouces can be allocated to Process:2 and available resources are: 3 3 2
Resouces can be allocated to Process:4 and available resources are: 5 3 2
Resouces can be allocated to Process:5 and available resources are: 7 4 3
Resouces can be allocated to Process:1 and available resources are: 7 4 5
Resouces can be allocated to Process:3 and available resources are: 7 5 5

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

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

8. Write a C program to simulate deadlock detection

```
#include <stdio.h>
#include <conio.h>
int max[100][100];
int alloc[100][100];
int need[100][100];
int avail[100]; int n,
r; void input(); void
show(); void cal();
int main()
{    int i,
j;
   printf("********** Deadlock Detection Algo ************\n");
input();    show();    cal();    getch();    return 0;
}
void input()
{    int i,
j;
   printf("Enter the no of Processes\t");
scanf("%d", &n);
   printf("Enter the no of resource instances\t");
scanf("%d", &r);    printf("Enter the request
Matrix\n");    for (i = 0; i < n; i++)
   { for (j = 0; j < r; j++)
      {
         scanf("%d", &max[i][j]);
      }
   }
   printf("Enter the Allocation Matrix\n");
for (i = 0; i < n; i++)
```

```
    {
        for (j = 0; j < r; j++)
        {
            scanf("%d", &alloc[i][j]);
        }
    }
    printf("Enter the available Resources\n");
for (j = 0; j < r; j++)
    {
        scanf("%d", &avail[j]);
    }
}
void show()
{     int i,
j;
    printf("Process\t Allocation\t Request\t Available\t");
for (i = 0; i < n; i++)
    {
        printf("\nP%d\t   ", i + 1);
for (j = 0; j < r; j++)
        {
            printf("%d ", alloc[i][j]);
        }        printf("\t");
for (j = 0; j < r; j++)
        {
            printf("%d ", max[i][j]);
        }
printf("\t");
if (i == 0)        {
            for (j = 0; j < r; j++)
printf("%d ", avail[j]);
        }
    }
}
```

```
void cal()
{
   int finish[100], temp, need[100][100], flag = 1, k, c1 = 0;
int dead[100];     int safe[100];
   int i, j;     for (i = 0; i
< n; i++)
   {        finish[i]
= 0;
   }
   // find need matrix
for (i = 0; i < n; i++)
   {
      for (j = 0; j < r; j++)
      {
         need[i][j] = max[i][j] - alloc[i][j];
      }
   }
   while (flag)
   {        flag = 0; for (i =
0; i < n; i++)
      {            int c = 0;
for (j = 0; j < r; j++)
         {
            if ((finish[i] == 0) && (need[i][j] <= avail[j]))
            {
c++;                    if (c
== r)                   {
                  for (k = 0; k < r; k++)
                  {
```

```
                        avail[k] += alloc[i][j];
finish[i] = 1;                          flag =
1;
                    }
                    // printf("\nP%d",i);
if (finish[i] == 1)
                    {
i = n;
                    }
                 }
              }
          }
       }    }     j = 0;
flag = 0;     for (i = 0; i
< n; i++)
   {        if (finish[i]
== 0)
       {
dead[j] = i;
j++;              flag =
1;
       }
   }     if (flag
== 1)
   {
       printf("\n\nSystem is in Deadlock and the Deadlock process are\n");
for (i = 0; i < n; i++)
       {
           printf("P%d\t", dead[i]);
       }
   }
else
   {
```

```
        printf("\nNo Deadlock Occur");
    }
}
```

Output:

```
********** Deadlock Detection Algo ************
Enter the no of Processes      5
Enter the no of resource instances      3
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
Enter the available Resources
0 0 0
Process  Allocation      Request         Available
P1        0 1 0       0 0 0   0 0 0
P2        2 0 0       2 0 2
P3        3 0 3       0 0 0
P4        2 1 1       1 0 0
P5        0 0 2       0 0 2
No Deadlock Occur
```

9.Write a C program to simulate the following contiguous memory allocation techniques a) Worst-fit

b) Best-fit

c) First-fit

```
#include <stdio.h>
void print(int processSize[], int allocation[], int n)
{    int
i;
    printf("\nProcess No.\tProcess Size\tBlock no.\n");
for (i = 0; i < n; i++)
    {
        printf(" %i\t\t\t", i + 1);
printf("%i\t", processSize[i]);         if
```

```
(allocation[i] != -1)
printf("%i", allocation[i] + 1);
else
        printf("Not Allocated");
printf("\n");
  }
}
void firstFit(int blockSize[], int m, int processSize[], int n)
{    int i,
j;
  // Stores block id of the      //
block allocated to a process    int
allocation[n];

  // Initially no block is assigned to any process
for (i = 0; i < n; i++)
  {
     allocation[i] = -1;
  }

  // pick each process and find suitable blocks     //
according to its size ad assign to it    for (i = 0; i < n;
i++) // here, n -> number of processes
  {
     for (j = 0; j < m; j++) // here, m -> number of blocks
     {
        if (blockSize[j] >= processSize[i])
        {
           // allocating block j to the ith process
allocation[i] = j;

           // Reduce available memory in this block.
           blockSize[j] -= processSize[i];
```

```
                break; // go to the next process in the queue
            }
        }
    }

    print(processSize, allocation, n);
}
void bestFit(int blockSize[], int m, int processSize[], int n)
{
    // Stores block id of the block allocated to a process
int allocation[n];     int i, j, bestIdx;
    // Initially no block is assigned to any process
for (i = 0; i < n; i++)         allocation[i] = -1;

    // pick each process and find suitable blocks
// according to its size ad assign to it     for (i =
0; i < n; i++)
    {
        // Find the best fit block for current process
bestIdx = -1;         for (j = 0; j < m; j++)
        {
            if (blockSize[j] >= processSize[i])
            {
                if (bestIdx == -1)
bestIdx = j;
                else if (blockSize[bestIdx] > blockSize[j])
bestIdx = j;
            }
        }
```

```
        // If we could find a block for current process
if (bestIdx != -1)
        {
            // allocate block j to p[i] process
allocation[i] = bestIdx;

            // Reduce available memory in this block.
blockSize[bestIdx] -= processSize[i];
        }
    }

    print(processSize, allocation, n);
}
// Function to allocate memory to blocks as per worst fit
// algorithm
void worstFit(int blockSize[], int m, int processSize[],
              int n)
{
    // Stores block id of the block allocated to a
    // process     int
allocation[n], i, j, wstIdx;

    // Initially no block is assigned to any process
for (i = 0; i < n; i++)        allocation[i] = -1;

    // pick each process and find suitable blocks
// according to its size ad assign to it     for (i =
0; i < n; i++)
    {
        // Find the best fit block for current process
wstIdx = -1;        for (j = 0; j < m; j++)
        {
            if (blockSize[j] >= processSize[i])
```

```
            {               if (wstIdx
== -1)                      wstIdx
= j;
                else if (blockSize[wstIdx] < blockSize[j])
wstIdx = j;
            }
        }

        // If we could find a block for current process
if (wstIdx != -1)
        {
            // allocate block j to p[i] process
            allocation[i] = wstIdx;

            // Reduce available memory in this block.
blockSize[wstIdx] -= processSize[i];
        }
    }

    print(processSize, allocation, n);
}
void main()
{
    int m,i; // number of blocks in the memory     int
n; // number of processes in the input queue     int
blockSize[20];     int processSize[20];     int
choice;
    printf("Enter the number of blocks\n");
scanf("%d",&m);
```

```
    printf("Enter the number of processes\n");
scanf("%d",&n);     printf("Enter the block
size\n");     for(i=0;i<m;i++)
    {
        scanf("%d",&blockSize[i]);
    }
    printf("Enter the process size\n");
for(i=0;i<n;i++)
    {
        scanf("%d",&processSize[i]);
    }
    printf("\n1.First-fit\n2.Best-fit\n3.Worst-fit\n");
printf("Enter your choice\n");     scanf("%d",&choice);
switch(choice)
    {
        case 1:firstFit(blockSize, m, processSize, n);
break;
        case 2:bestFit(blockSize,m,processSize,n);
            break;
        case 3:worstFit(blockSize,m,processSize,n);
break;
        default:printf("invalid choice\n");
    }

}
```

Output:

```
Enter the number of blocks
6
Enter the number of processes
4
Enter the block size
200
700
500
300
100
400
Enter the process size
315
427
250
550

1.First-fit
2.Best-fit
3.Worst-fit
Enter your choice
1

Process No.     Process Size    Block no.
 1                      315     2
 2                      427     3
 3                      250     2
 4                      550     Not Allocated
```

```
Enter the number of blocks
6
Enter the number of processes
4
Enter the block size
200
700
500
300
100
400
Enter the process size
315
427
250
550

1.First-fit
2.Best-fit
3.Worst-fit
Enter your choice
2

Process No.     Process Size    Block no.
 1                      315     6
 2                      427     3
 3                      250     4
 4                      550     2
```

```
Enter the number of blocks
6
Enter the number of processes
4
Enter the block size
200
700
500
300
100
400
Enter the process size
315
427
250
550

1.First-fit
2.Best-fit
3.Worst-fit
Enter your choice
3

Process No.     Process Size    Block no.
 1                      315     2
 2                      427     3
 3                      250     6
 4                      550     Not Allocated
```

10. Write a C program to simulate paging technique of memory management.

```
#include <stdio.h> void main()
{
   int ms, ps, nop, np, rempages, i, j, x, y, pa, offset;
int s[10], fno[10][20];
   printf("\nEnter the memory size -- ");
scanf("%d", &ms);

   printf("\nEnter the page size -- ");
scanf("%d", &ps);

   nop = ms / ps;
   printf("\nThe no. of pages available in memory are -- %d ", nop);

   printf("\nEnter number of processes -- ");
scanf("%d", &np);     rempages = nop;
   for (i = 1; i <= np; i++)

   {

      printf("\nEnter no. of pages required for p[%d]-- ", i);
scanf("%d", &s[i]);

      if (s[i] > rempages)
      {

         printf("\nMemory is Full");
break;
      }
      rempages = rempages - s[i];
```

```
        printf("\nEnter pagetable for p[%d] --- ", i);
for (j = 0; j < s[i]; j++)                scanf("%d",
&fno[i][j]);
    }

    printf("\nEnter Logical Address to find Physical Address ");
printf("\nEnter process no. and pagenumber and offset -- ");

    scanf("%d %d %d", &x, &y, &offset);

    if (x > np || y >= s[i] || offset >= ps)
        printf("\nInvalid Process or Page Number or offset");

    else
    {
        pa = fno[x][y] * ps + offset;        printf("\nThe
Physical Address is -- %d", pa);
    }
}
```

Output:

```
Enter the memory size -- 1000

Enter the page size -- 100

The no. of pages available in memory are -- 10
Enter number of processes -- 3

Enter no. of pages required for p[1]-- 4

Enter pagetable for p[1] --- 8 6 9 5

Enter no. of pages required for p[2]-- 5

Enter pagetable for p[2] --- 1 4 5 7 3

Enter no. of pages required for p[3]-- 5

Memory is Full
Enter Logical Address to find Physical Address
Enter process no. and pagenumber and offset -- 2 3 60

The Physical Address is -- 760
```

11. Write a C program to simulate page replacement algorithms

a) FIFO

b) LRU

c) Optimal #include<stdio.h>

```
int n,nf; int
in[100]; int
p[50]; int
hit=0; int
i,j,k;
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",&nf);
}

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

int isHit(int data)
{
```

```
   hit=0;     for(j=0;
j<nf; j++)
   {
if(p[j]==data)
       {
hit=1;
break;
       }

   }
    return
hit;
}

int getHitIndex(int data)
{              int   hitind;
for(k=0; k<nf; k++)
   {
       if(p[k]==data)
       {
hitind=k;
break;
       }
   }
   return hitind;
}

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

```
}

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

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

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

            for(k=0; k<nf-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<nf;
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:1

Enter length of page reference sequence:6

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

Enter no of frames:3

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

For 1 : 1
For 2 : 1 2
For 5 : 1 2 5
For 3 : 2 5 3
For 1 : 5 3 1
For 2 : 3 1 2
Total no of page faults:6
Page Replacement Algorithms
1.Enter data
2.FIFO
3.Optimal
4.LRU
5.Exit
Enter your choice:3

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

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

For 1 : 1
For 2 : 1 2
For 5 : 1 2 5
For 3 : 3 2 5
For 1 : 3 1 5
For 2 : 3 1 2
Total no of page faults:6
Page Replacement Algorithms
1.Enter data
2.FIFO
3.Optimal
4.LRU
5.Exit
Enter your choice:5
```

12. Write a C program to simulate disk scheduling algorithms

a) FCFS b) SCAN c) C-SCAN

a)FCFS

```
/*FCFCS*/
#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);

    // logic for FCFS disk scheduling

    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 14 134 65 67
Enter initial head position
53
Total head moment is 660
```

b)SCAN

```
#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);

   // logic for Scan disk scheduling

   /*logic for sort the request array */
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 movement is towards high value
if (move == 1)
    {
        for (i = index; i < n; i++)
        {
            TotalHeadMoment = TotalHeadMoment + abs(RQ[i] - initial);
initial = RQ[i];
        }
        //  last movement for max size
        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];

        }
    }
    // if movement is towards low value
else
    {
        for (i = index - 1; i >= 0; i--)
        {
```

```
            TotalHeadMoment = TotalHeadMoment + abs(RQ[i] - initial);
initial = RQ[i];
        }
        //  last movement for min size
        TotalHeadMoment = TotalHeadMoment + abs(RQ[i + 1] - 0);
initial = 0;         for (i = index; i < n; i++)
        {
            TotalHeadMoment = TotalHeadMoment + abs(RQ[i] - initial);
initial = RQ[i];
        }
    }

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

Output:

```
Enter the number of Requests
8
Enter the Requests sequence
98 183 37 122 14 124 65 67
Enter initial head position
53
Enter total disk size
200
Enter the head movement direction for high 1 and for low 0
0
Total head movement is 236
```

c)C-SCAN

```
#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);

    // logic for C-Scan disk scheduling

    /*logic for sort the request array */
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;
        }
```

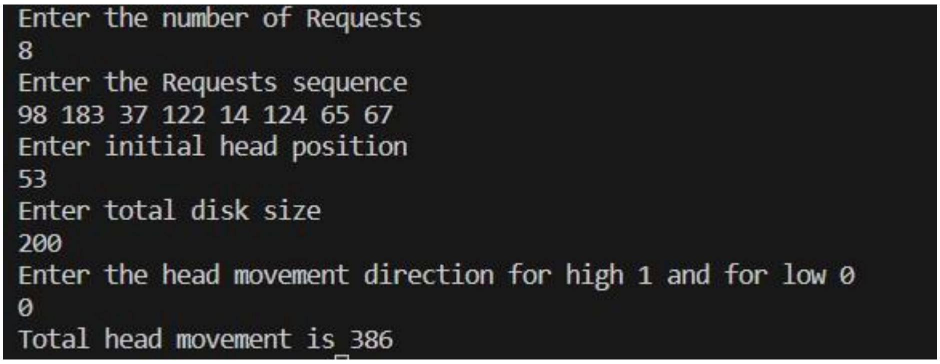
```
    }

    // if movement is towards high value
if (move == 1)
    {
        for (i = index; i < n; i++)
        {
            TotalHeadMoment = TotalHeadMoment + abs(RQ[i] - initial);
initial = RQ[i];
        }
        //  last movement for max size
        TotalHeadMoment = TotalHeadMoment + abs(size - RQ[i - 1] - 1);
        /*movement max to min disk */
        TotalHeadMoment = TotalHeadMoment + abs(size - 1 - 0);
initial = 0;        for (i = 0; i < index; i++)
        {
            TotalHeadMoment = TotalHeadMoment + abs(RQ[i] - initial);
initial = RQ[i];
        }
    }
    // if movement is towards low value
    else
    {
        for (i = index - 1; i >= 0; i--)
        {
            TotalHeadMoment = TotalHeadMoment + abs(RQ[i] - initial);
initial = RQ[i];
        }
        //  last movement for min size
        TotalHeadMoment = TotalHeadMoment + abs(RQ[i + 1] - 0);
        /*movement min to max disk */
```

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

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

Output:



```
Enter the number of Requests
8
Enter the Requests sequence
98 183 37 122 14 124 65 67
Enter initial head position
53
Enter total disk size
200
Enter the head movement direction for high 1 and for low 0
0
Total head movement is 386
```

13. Write a C program to simulate disk scheduling algorithms

a) SSTF b) LOOK c) c-LOOK

a)SSTF

```
#include <stdio.h>
#include <stdlib.h> int
main()
{
    int RQ[100], i, n, TotalHeadMoment = 0, initial, count = 0;
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);

   // logic for sstf disk scheduling

   /* loop will execute until all process is completed*/
while (count != n)
   {
       int min = 1000, d, index;
for (i = 0; i < n; i++)
       {
           d = abs(RQ[i] - initial);
if (min > d)
           {
min        =        d;
index = i;
           }
       }
       TotalHeadMoment = TotalHeadMoment + min;
       initial = RQ[index];
       // 1000 is for max
       // you can use any number
RQ[index] = 1000;        count++;
   }

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

Output:

```
Enter the number of Requests
8
Enter the Requests sequence
98
183 37 122 14 124 65 67
Enter initial head position
53
Total head movement is 236
```

b)LOOK

```
#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);


   // logic for look disk scheduling


   /*logic for sort the request array */

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

        for (i = index - 1; i >= 0; i--)
        {
            TotalHeadMoment = TotalHeadMoment + abs(RQ[i] - initial);
initial = RQ[i];
        }
    }
    // if movement is towards low value
else
    {
```

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

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

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

Output:

```
Enter the number of Requests
8
Enter the Requests sequence
98 183 37 122 14 124 65 67
Enter initial head position
53
Enter total disk size
200
Enter the head movement direction for high 1 and for low 0
0
Total head movement is 208
```

c)C-LOOK

```
#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);

    // logic for C-look disk scheduling

    /*logic for sort the request array */
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 movement is towards high value
if (move == 1)
    {
        for (i = index; i < n; i++)
        {
            TotalHeadMoment = TotalHeadMoment + abs(RQ[i] - initial);
initial = RQ[i];
        }

        for (i = 0; i < index; i++)
        {
            TotalHeadMoment = TotalHeadMoment + abs(RQ[i] - initial);
initial = RQ[i];
        }
    }
    // if movement is towards low value
else
    {
        for (i = index - 1; i >= 0; i--)
        {
            TotalHeadMoment = TotalHeadMoment + abs(RQ[i] - initial);
initial = RQ[i];
        }

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

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

Output:

```
Enter the number of Requests
8
Enter the Requests sequence
98 183 37 122 14 124 65 67
Enter initial head position
53
Enter total disk size
200
Enter the head movement direction for high 1 and for low 0
0
Total head movement is 326
```