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LAB REPORT
on

OPERATING SYSTEMS

Submitted by

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in partial fulfillment for the award of the degree of
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CERTIFICATE

This is to certify that the Lab work entitled "OPERATING SYSTEMS" carried out by **DHIKSHA RATHIS (1BM21CS055),** who is a bonafide student of **B.M.S. College of Engineering.** It is in partial fulfillment for the award of **Bachelor of Engineering in Computer Science and Engineering** of the Visvesvaraya Technological University, Belgaum during the academic semester June-2023 to September-2023. The Lab report has been approved as it satisfies the academic requirements in respect of a OPERATING SYSTEMS **(22CS4PCOPS)** work prescribed for the said degree.

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Course Outcome

CO1	Apply the different concepts and functionalities of Operating Systems.
CO2	Analyze various Operating system strategies and techniques.
CO3	Demonstrate the different functionalities of Operating Systems.
CO4	Conduct practical experiments to implement the functionalities of Operating systems.

LAB PROGRAM 1

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

- FCFS
- SJF (preemptive & Non-pre-emptive)

FCFS:

```
#include<stdio.h>
int main()
{
   int bt[20], at[20], wt[20], tat[20],ct[20], i, n;
   float wtavg, tatavg;
   printf("\nEnter the number of processes: ");
   scanf("%d", &n);
   for(i=1;i<=n;i++)
   {
       printf("\nEnter Arrival Time and Burst Time for Process %d: ", i);
      scanf("%d %d", &at[i], &bt[i]);
   }
  for(i=1; i<=n; i++)
   {
      ct[i]=bt[i]+ct[i-1];
   }
  for(i=1; i<=n; i++)
   {
```

```
    tat[i]=ct[i]-at[i];
    wt[i]=tat[i]-bt[i];
    tatavg=tatavg+tat[i];
    wtavg=wtavg+wt[i];
  }
  printf("\t PROCESS \tBURST TIME \t WAITING TIME\t TURNAROUND TIME\n");
  for(i=1;i<=n;i++)
  {
    printf("\n\t P%d \t\t %d \t\t %d \t\t %d", i, bt[i], wt[i], tat[i]);
  }
  printf("\nAverage Turnaround Time: %f", tatavg/n);
  printf("\nAverage Waiting Time: %f", wtavg/n);
}
```

OUTPUT:

```
Enter the number of processes: 4

Enter Arrival Time and Burst Time for Process 1: 0 3

Enter Arrival Time and Burst Time for Process 2: 1 6

Enter Arrival Time and Burst Time for Process 3: 4 4

Enter Arrival Time and Burst Time for Process 4: 6 2
        PROCESS        BURST TIME       WAITING TIME    TURNAROUND TIME

        P1              3               0               3
        P2              6               2               8
        P3              4               5               9
        P4              2               7               9
Average Turnaround Time: 7.250000
Average Waiting Time: 3.500000
```

```
Enter the number of processes: 5

Enter Arrival Time and Burst Time for Process 1: 0 1

Enter Arrival Time and Burst Time for Process 2: 0 10

Enter Arrival Time and Burst Time for Process 3: 3 2

Enter Arrival Time and Burst Time for Process 4: 5 1

Enter Arrival Time and Burst Time for Process 5: 10 5
        PROCESS        BURST TIME       WAITING TIME    TURNAROUND TIME

        P1              1               0               1
        P2              10              1               11
        P3              2               8               10
        P4              1               8               9
        P5              5               4               9
Average Turnaround Time: 8.000000
Average Waiting Time: 4.200000
```

SJF (Non-Pre-emptive):

```
#include<stdio.h>
int at[20], cput[20];
void sjf(int n)
{
   int cmpt[20],tat[20],wt[20],cput1[20];
   float awt=0, atat=0,sum_burst_time=0;
   int sum=0,i,j, smallest;
   printf("\t PROCESS \t TURNAROUND TIME\t WAITING TIME\n");
   for (i = 0; i < n; i++)
  {
        cput1[i]=cput[i];
        sum_burst_time += cput[i];
  }
```

```
   cput1[9]=9999;
   while(sum < sum_burst_time)
  {
        smallest = 9;
        for (i = 0; i < n; i++)
        {
              if (at[i] <= sum && cput1[i] > 0 && cput1[i] < cput1[smallest])
              smallest = i;
        }
        printf("\t P[%d] \t\t %d \t\t %d\n", smallest , sum + cput1[smallest]-
        at[smallest], sum - at[smallest]);
        awt += sum + cput1[smallest] - at[smallest];
        atat += sum - at[smallest];
        sum += cput1[smallest];
        cput1[smallest] = 0;
    }
    awt = awt/n;
    atat =atat/n;
   printf("\nAverage Waiting Time -- %f", awt);
   printf("\nAverage Turnaround Time -- %f\n", atat);
}
void main()
{
        int n,i;
        printf("Enter the number of processes\n");
        scanf("%d",&n);
```

```
        printf("Enter arrival time and cpu time for each process respectively\n");
        for(i =0;i<n;i++)
        {
                scanf("%d %d",&at[i],&cput[i]);
        }
        sjf(n);
}
```

OUTPUT:

```
Enter arrival time and cpu time for each process respectively
0 3
1 6
4 4
6 2
        PROCESS         TURNAROUND TIME         WAITING TIME
        P[0]            3                       0
        P[1]            8                       2
        P[3]            5                       3
        P[2]            11                      7

Average Waiting Time -- 6.750000
Average Turnaround Time -- 3.000000
```

```
Enter the number of processes: 5
Enter arrival time and cpu time for each process respectively
0 10
0 1
3 2
5 2
2 5
        PROCESS         TURNAROUND TIME         WAITING TIME
        P[1]            1                       0
        P[0]            11                      1
        P[2]            10                      8
        P[3]            10                      8
        P[4]            18                      13

Average Waiting Time -- 10.000000
Average Turnaround Time -- 6.000000
```

SJF (Pre-emptive):

```
#include<stdio.h>
int at[20], cput[20];
void srtf(int n)
{
   int remaining_time[20], tat[20], wt[20], completion_time[20], smallest, time, i,
count = 0;
   float awt=0,atat=0;
   for (i = 0; i < n; i++)
      remaining_time[i] = cput[i];
   time = 0;
   while (count != n)
   {
      smallest = -1;
      for (i = 0; i < n; i++)
      {
         if (at[i] <= time && remaining_time[i] > 0)
         {
            if (smallest == -1 || remaining_time[i] < remaining_time[smallest])
               smallest = i;
         }
      }

      if (smallest == -1) {
         time++;
         continue;
```

```
    }

    remaining_time[smallest]--;

    if (remaining_time[smallest] == 0) {
      count++;
      completion_time[smallest] = time + 1;
      wt[smallest] = completion_time[smallest] - at[smallest] - cput[smallest];
      tat[smallest] = completion_time[smallest] - at[smallest];
    }

    time++;
  }
  for(i=0;i<n;i++)
  {
    awt+=wt[i];
    atat += tat[i];
  }
  awt = awt/n;
  atat =atat/n;
  printf("\nProcess\tArrival Time\tCPU Time\tWaiting Time\tTurnaround Time\n");
  for (i = 0; i < n; i++)
  {
    printf("%d\t%d\t\t%d\t\t%d\t\t%d\n", i, at[i], cput[i], wt[i], tat[i]);
  }
```

```
    printf("\nAverage Waiting Time -- %f", awt);
    printf("\nAverage Turnaround Time -- %f\n", atat);


}
void main()
{
    int n,i,choice;
    printf("Enter the number of processes\n");
    scanf("%d",&n);
    printf("Enter arrival time and cpu time for each process respectively\n");
    for(i =0;i<n;i++)
    {
       scanf("%d %d",&at[i],&cput[i]);
    }
    srtf(n);
}
```

OUTPUT:

```
Enter the number of processes
4
Enter arrival time and cpu time for each process respectively
0 3
1 6
4 4
6 2

Process Arrival Time    CPU Time        Waiting Time    Turnaround Time
0       0               3               0               3
1       1               6               8               14
2       4               4               0               4
3       6               2               2               4

Average Waiting Time -- 2.500000
Average Turnaround Time -- 6.250000
```

```
Enter the number of processes
03
Enter arrival time and cpu time for each process respectively
0 8
0 4
1 1

Process Arrival Time    CPU Time        Waiting Time    Turnaround Time
0       0               8               5               13
1       0               4               1               5
2       1               1               0               1

Average Waiting Time -- 2.000000
Average Turnaround Time -- 6.333333
```

LAB PROGRAM 2

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

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

Priority (Pre-emptive & Non-pre-emptive):

```
#include <stdio.h>
#include <stdbool.h>
#include<stdlib.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 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);
}

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, burst time, priority: ");
        scanf("%d %d %d", &processes[i].arrival_time, &processes[i].burst_time,
&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("1. Priority Non-preemptive\n");
    printf("2. Priority Preemptive\n");
    printf("3. Exit\n");
    while(1)
    {
        printf("Enter your choice: ");
        scanf("%d", &choice);
        switch (choice) {
            case 1:
                printf("\nPriority Non-preemptive Scheduling:\n");
                priority_nonpreemptive(processes, n);
                break;

            case 2:
                    printf("\nPriority Preemptive Scheduling:\n");
                    priority_preemptive(processes, n);
                    break;
            case 3: exit(0); break;
            default: printf("Invalid choice!\n");
        }
```

```
    }
return 0;
}
```

OUTPUT:

```
Enter the number of processes: 4
Process 1
Enter arrival time, burst time, priority: 0 4 3
Process 2
Enter arrival time, burst time, priority: 1 3 4
Process 3
Enter arrival time, burst time, priority: 2 3 6
Process 4
Enter arrival time, burst time, priority: 3 5 5
1. Priority Non-preemptive
2. Priority Preemptive
3. Exit
Enter your choice: 1

Priority Non-preemptive Scheduling:
Process Turnaround Time Waiting Time
1       4               0
2       6               3
4       9               4
3       13              10
Average Turnaround Time: 8.00
Average Waiting Time: 4.25
Enter your choice: 2

Priority Preemptive Scheduling:
Process Turnaround Time Waiting Time
1       4               0
2       6               3
4       9               4
3       13              10
Average Turnaround Time: 8.00
Average Waiting Time: 4.25
Enter your choice: 3
```

```
Enter the number of processes: 4
Process 1
Enter arrival time, burst time, priority: 0 5 4
Process 2
Enter arrival time, burst time, priority: 2 4 2
Process 3
Enter arrival time, burst time, priority: 2 2 6
Process 4
Enter arrival time, burst time, priority: 4 4 3
1. Priority Non-preemptive
2. Priority Preemptive
3. Exit
Enter your choice: 1

Priority Non-preemptive Scheduling:
Process Turnaround Time Waiting Time
1       5               0
2       7               3
4       9               5
3       13              11
Average Turnaround Time: 8.50
Average Waiting Time: 4.75
Enter your choice: 2

Priority Preemptive Scheduling:
Process Turnaround Time Waiting Time
1       13              8
2       4               0
4       6               2
3       13              11
Average Turnaround Time: 9.00
Average Waiting Time: 5.25
Enter your choice: 3
```

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

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

```
#include<stdbool.h>
struct P
{
   int AT,BT,ST[20],WT,FT,TAT,pos;
};
int quant;
int main()
{
   int n,i,j;
   printf("Enter the no. of processes :");
   scanf("%d",&n);
   struct P p[n];
   printf("Enter the quantum \n");
   scanf("%d",&quant);
   printf("Enter the process numbers \n");
   for(i=0;i<n;i++)
      scanf("%d",&(p[i].pos));
   printf("Enter the Arrival time of processes \n");
   for(i=0;i<n;i++)
      scanf("%d",&(p[i].AT));
   printf("Enter the Burst time of processes \n");
   for(i=0;i<n;i++)
      scanf("%d",&(p[i].BT));
   int c=n,s[n][20];
   float time=0, mini=INT_MAX, b[n], a[n];
   int index=-1;
   for(i=0;i<n;i++)
   {
      b[i]=p[i].BT;
      a[i]=p[i].AT;
      for(j=0;j<20;j++)
      {
         s[i][j]=-1;
```

```
    }
}
int tot_wt,tot_tat;
tot_wt=0;
tot_tat=0;
bool flag=false;
while(c!=0)
{
    mini=INT_MAX;
    flag=false;
    for(i=0;i<n;i++)
    {
        float p=time+0.1;
        if(a[i]<=p && mini>a[i] && b[i]>0)
        {
            index=i;
            mini=a[i];
            flag=true;

        }
    }
    if(!flag)
    {
        time++;
        continue;
    }
    j=0;
    while(s[index][j]!=-1)
    {
        j++;
    }
    if(s[index][j]==-1)
    {
```

```
      s[index][j]=time;
      p[index].ST[j]=time;
   }
   if(b[index]<=quant)
   {
      time+=b[index];
      b[index]=0;
   }
   else
   {
      time+=quant;
      b[index]-=quant;
   }
   if(b[index]>0)
   {
      a[index]=time+0.1;
   }
   if(b[index]==0)
   {
      c--;
      p[index].FT=time;
      p[index].WT=p[index].FT-p[index].AT-p[index].BT;
      tot_wt+=p[index].WT;
      p[index].TAT=p[index].BT+p[index].WT;
      tot_tat+=p[index].TAT;
   }

}
printf("Process number ");
printf("Arrival time ");
printf("Burst time ");
printf("\tStart time");
j=0;
```

```
while(j!=10)
{
   j+=1;
   printf(" ");
}
printf("\t\tFinal time");
printf("\tWait Time ");
printf("\tTurnAround Time \n");
for(i=0;i<n;i++)
{
   printf("%d \t\t",p[i].pos);
   printf("%d \t\t",p[i].AT);
   printf("%d \t",p[i].BT);
   j=0;
   int v=0;
   while(s[i][j]!=-1)
   {
      printf("%d ",p[i].ST[j]);
      j++;
      v+=3;
   }
   while(v!=40)
   {
      printf(" ");
      v+=1;
   }
   printf("%d \t\t",p[i].FT);
   printf("%d \t\t",p[i].WT);
   printf("%d \n",p[i].TAT);
}
double avg_wt,avg_tat;
avg_wt=tot_wt/(float)n;
avg_tat=tot_tat/(float)n;
```

```
    printf("The average wait time is : %lf\n",avg_wt);
    printf("The average TurnAround time is : %lf\n",avg_tat);
    return 0;
}
```

OUTPUT:

```
Enter the no. of processes :5
Enter the quantum
2
Enter the process numbers
1 2 3 4 5
Enter the Arrival time of processes
0 1 2 3 4
Enter the Burst time of processes
5 3 1 2 3
Process number Arrival time Burst time  Start time                    Final time      Wait Time       TurnAround Time
1              0              5       0 5 12                          13              8               13
2              1              3       2 11                             12              8               11
3              2              1       4                                5               2               3
4              3              2       7                                9               4               6
5              4              3       9 13                             14              7               10
The average wait time is : 5.800000
The average TurnAround time is : 8.600000
```

```
Enter the no. of processes :5
Enter the quantum
1
Enter the process numbers
1 2 3 4 5
Enter the Arrival time of processes
0 3 4 4 5
Enter the Burst time of processes
7 2 1 3 3
Process number Arrival time Burst time  Start time                    Final time      Wait Time       TurnAround Time
1              0              7       0 1 2 4 9 12 15                 16              9               16
2              3              2       3 7                              8               3               5
3              4              1       5                                6               1               2
4              4              3       6 10 13                          14              7               10
5              5              3       8 11 14                          15              7               10
The average wait time is : 5.400000
The average TurnAround time is : 8.600000
```

LAB PROGRAM 3

Write a C program to simulate a 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>
int spat[10], upat[10], i, n1, n2, p1[10], p2[10];
int sppt[10], uppt[10], time = 0, op = 0, y, z, pt;
int sptat[10], uptat[10];
int spwt[10], upwt[10];
float spatat = 0, spawt = 0;
float upatat = 0, upawt = 0;
void process(int x, int isSystem) {
   if (isSystem) {
      op += sppt[x];
      sptat[x] = op - spat[x];
      sppt[x] = 0;
      spwt[x] = sptat[x] - p1[x];
      spatat += sptat[x];
      spawt += spwt[x];
   } else {
      op += uppt[x];
      uptat[x] = op - upat[x];
      uppt[x] = 0;
```

```
        upwt[x] = uptat[x] - p2[x];
        upatat += uptat[x];
        upawt += upwt[x];
    }
}
int main() {
    printf("Enter the number of System Processes: ");
    scanf("%d", &n1);
    printf("Enter the number of User Processes: ");
    scanf("%d", &n2);
    printf("Enter the arrival times for System Processes:\n");
    for (i = 0; i < n1; i++)
        scanf("%d", &spat[i]);
    printf("Enter the burst times for System Processes:\n");
    for (i = 0; i < n1; i++)
        scanf("%d", &sppt[i]);
    printf("Enter the arrival times for User Processes:\n");
    for (i = 0; i < n2; i++)
        scanf("%d", &upat[i]);
    printf("Enter the burst times for User Processes:\n");
    for (i = 0; i < n2; i++)
        scanf("%d", &uppt[i]);
    for (i = 0; i < n1; i++)
        time += sppt[i];
    for (i = 0; i < n2; i++)
        time += uppt[i];
```

```
for (i = 0; i < n1; i++)
   p1[i] = sppt[i];
for (i = 0; i < n2; i++)
   p2[i] = uppt[i];
printf("\n");
while (op < time) {
   y = -1;
   z = -1;
   for (i = 0; i < n1; i++) {
      if (op >= spat[i] && sppt[i] != 0) {
         y = i;
         break;
      }
   }
   for (i = 0; i < n2; i++) {
      if (op >= upat[i] && uppt[i] != 0) {
         z = i;
         break;
      }
   }
   if (y != -1) {
      printf("%d SP%d ", op, y + 1);
      process(y, 1);
   } else if (z != -1) {
      printf("%d UP%d ", op, z + 1);
      process(z, 0);
```

```
        } else {
            op++;
        }
    }
    printf("%d ",op);
    printf("\n");
    printf("System Processes:\n");
    for (i = 0; i < n1; i++)
        printf("SP%d %d 0\n", i + 1, sptat[i]);
    printf("Average Turnaround Time (System Processes): %.2f\n", spatat / n1);
    printf("Average Waiting Time (System Processes): 0\n");
    printf("\n");
    printf("User Processes:\n");
    for (i = 0; i < n2; i++)
        printf("UP%d %d %d\n", i + 1, uptat[i], upwt[i]);
    printf("Average Turnaround Time (User Processes): %.2f\n", upatat / n2);
    printf("Average Waiting Time (User Processes): %.2f\n", upawt / n2);
    return 0;
}
```

OUTPUT:

```
Enter the number of System Processes: 2
Enter the number of User Processes: 2
Enter the arrival times for System Processes:
0 10
Enter the burst times for System Processes:
4 5
Enter the arrival times for User Processes:
0 0
Enter the burst times for User Processes:
3 8

0 SP1 4 UP1 7 UP2 15 SP2 20
System Processes:
SP1 4 0
SP2 10 0
Average Turnaround Time (System Processes): 7.00
Average Waiting Time (System Processes): 0

User Processes:
UP1 7 4
UP2 15 7
Average Turnaround Time (User Processes): 11.00
Average Waiting Time (User Processes): 5.50
```

```
Enter the number of System Processes: 3
Enter the number of User Processes: 1
Enter the arrival times for System Processes:
0 0 10
Enter the burst times for System Processes:
4 3 5
Enter the arrival times for User Processes:
0
Enter the burst times for User Processes:
8

0 SP1 4 SP2 7 UP1 15 SP3 20
System Processes:
SP1 4 0
SP2 7 0
SP3 10 0
Average Turnaround Time (System Processes): 7.00
Average Waiting Time (System Processes): 0

User Processes:
UP1 15 7
Average Turnaround Time (User Processes): 15.00
Average Waiting Time (User Processes): 7.00
```

LAB PROGRAM 4

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

- Rate- Monotonic
- Earliest-deadline First

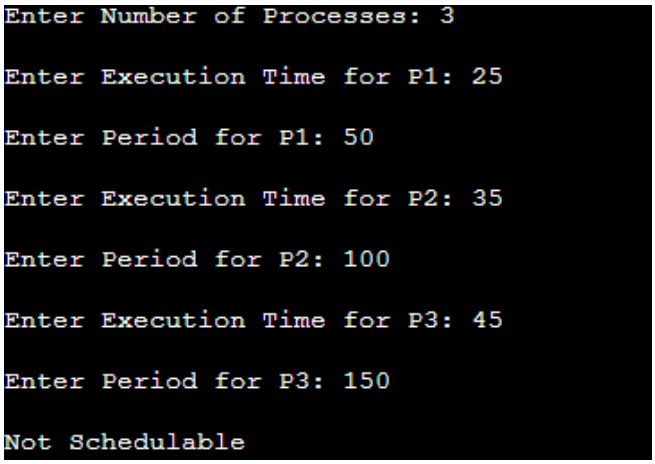
Rate- Monotonic:

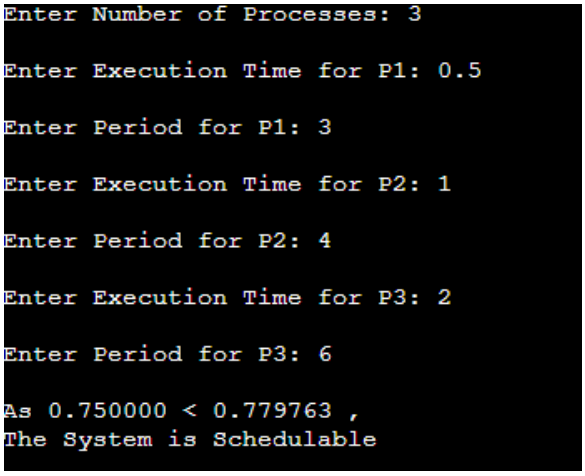
```
#include<stdio.h>
#include<math.h>
void main()
{
  int n;
  float e[20],p[20];
  int i;
  float ut,u,x,y;
  printf("Enter Number of Processes: ");
  scanf("%d",&n);
  for(i=0;i<n;i++)
  {
   printf("\nEnter Execution Time for P%d: ",(i+1));
   scanf("%f",&e[i]);
   printf("\nEnter Period for P%d: ",(i+1));
   scanf("%f",&p[i]);
  }
  for(i=0;i<n;i++)
  {
   x=e[i]/p[i];
```

```
  ut+=x;
 }
 y=(float)n;
 y=y*((pow(2.0,1/y))-1);
 u=y;
 if(ut<u)
 {
printf("\nAs %f < %f ,",ut,u);
printf("\nThe System is Schedulable");
 }
 else
printf("\nNot Schedulable");

}
```

OUTPUT:





Earliest-deadline First:

```
#include <stdio.h>
#include <stdlib.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)
{ if (b == 0)
return a;
else
return gcd(b, a % 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()
{ task *t;
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)
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;
}
```

OUTPUT:

```
Enter number of tasks
3
Enter Task 1 parameters
Arrival time: 0
Execution time: 3
Deadline time: 20
Period: 20
Enter Task 2 parameters
Arrival time: 0
Execution time: 2
Deadline time: 5
Period: 5
Enter Task 3 parameters
Arrival time: 0
Execution time: 2
Deadline time: 20
Period: 20
CPU Utilization 0.650000
Tasks can be scheduled
0  Task 2
1  Task 2
2  Task 1
3  Task 1
4  Task 1
5  Task 2
6  Task 2
7  Task 3
8  Task 3
9  Idle
10  Task 2
11  Task 2
12  Idle
13  Idle
14  Idle
15  Task 2
16  Task 2
17  Idle
18  Idle
19  Idle
20  Task 2
```

```
Enter number of tasks
2
Enter Task 1 parameters
Arrival time: 0
Execution time: 25
Deadline time: 50
Period: 50
Enter Task 2 parameters
Arrival time: 0
Execution time: 35
Deadline time: 80
Period: 80
CPU Utilization 0.937500
Tasks can be scheduled
0  Task 1
1  Task 1
2  Task 1
3  Task 1
4  Task 1
5  Task 1
6  Task 1
7  Task 1
8  Task 1
9  Task 1
10  Task 1
11  Task 1
12  Task 1
13  Task 1
14  Task 1
15  Task 1
16  Task 1
17  Task 1
18  Task 1
19  Task 1
20  Task 1
21  Task 1
22  Task 1
23  Task 1
24  Task 1
25  Task 2
26  Task 2
27  Task 2
28  Task 2
29  Task 2
```

LAB PROGRAM 5

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

```
#include <stdio.h>
#include <stdlib.h>
#include <pthread.h>
#include <semaphore.h>
#define BUFFER_SIZE 5
#define MAX_ITEMS 20
int buffer[BUFFER_SIZE];
int in = 0;
int out = 0;
int produced_count = 0;
int consumed_count = 0;
sem_t mutex;
sem_t full;
sem_t empty;
void* producer(void* arg) {
  int item = 1;
  while (produced_count < MAX_ITEMS) {
    sem_wait(&empty);
    sem_wait(&mutex);
    buffer[in] = item;
    printf("Produced: %d\n", item);
```

```
    item++;
    in = (in + 1) % BUFFER_SIZE;
    produced_count++;
    sem_post(&mutex);
    sem_post(&full);
  } pthread_exit(NULL);
}
void* consumer(void* arg) {
  while (consumed_count < MAX_ITEMS) {
    sem_wait(&full);
    sem_wait(&mutex);
    int item = buffer[out];
    printf("Consumed: %d\n", item);
    out = (out + 1) % BUFFER_SIZE;
    consumed_count++;
    sem_post(&mutex);
    sem_post(&empty);
  } pthread_exit(NULL);
}
int main() {
  pthread_t producerThread, consumerThread;
  sem_init(&mutex, 0, 1);
  sem_init(&full, 0, 0);
  sem_init(&empty, 0, BUFFER_SIZE);
  pthread_create(&producerThread, NULL, producer, NULL);
  pthread_create(&consumerThread, NULL, consumer, NULL);
```

```
    pthread_join(producerThread, NULL);
    pthread_join(consumerThread, NULL);
    sem_destroy(&mutex);
    sem_destroy(&full);
    sem_destroy(&empty);
    return 0;
}
```

OUTPUT:

```
Produced: 1
Produced: 2
Produced: 3
Produced: 4
Produced: 5
Consumed: 1
Consumed: 2
Consumed: 3
Consumed: 4
Consumed: 5
Produced: 6
Produced: 7
Produced: 8
Produced: 9
Produced: 10
Consumed: 6
Consumed: 7
Consumed: 8
Consumed: 9
Consumed: 10
Produced: 11
Produced: 12
Produced: 13
Produced: 14
Produced: 15
Consumed: 11
Consumed: 12
Consumed: 13
Consumed: 14
Consumed: 15
Produced: 16
Produced: 17
Produced: 18
Produced: 19
Produced: 20
Consumed: 16
Consumed: 17
Consumed: 18
Consumed: 19
Consumed: 20
```

```
Produced: 1
Produced: 2
Produced: 3
Produced: 4
Produced: 5
Consumed: 1
Produced: 6
Consumed: 2
Produced: 7
Consumed: 3
Produced: 8
Consumed: 4
Produced: 9
Consumed: 5
Produced: 10
Consumed: 6
Produced: 11
Consumed: 7
Produced: 12
Consumed: 8
Produced: 13
Consumed: 9
Produced: 14
Consumed: 10
Produced: 15
Consumed: 11
Consumed: 12
Consumed: 13
Consumed: 14
Consumed: 15
Produced: 16
Produced: 17
Produced: 18
Consumed: 16
Consumed: 17
Consumed: 18
Produced: 19
Produced: 20
Consumed: 19
Consumed: 20
```

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

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

LAB PROGRAM 7

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

```
#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("********** Banker's 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 resources instances\t");
scanf("%d",&r);
printf("Enter the Max 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 Max\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 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];
 }
}
printf("\n");
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("P%d->",i);
     if(finish[i]==1)
    {
      i=n;
     }
        }
  }
 }
  }
}
for(i=0;i<n;i++)
{
if(finish[i]==1)
{
 c1++;
}
else
```

```
 {
  printf("P%d->",i);
 }
}
if(c1==n)
{
 printf("\n The system is in safe state");
}
else
{
 printf("\n Process are in dead lock");
 printf("\n System is in unsafe state");
}
}
```

OUTPUT:

```
********** Baner's Algo ************
Enter the no of Processes       5
Enter the no of resources instances     3
Enter the Max Matrix
7 5 3
3 2 2
9 0 2
2 2 2
4 3 3
Enter the Allocation Matrix
0 1 0
2 0 0
3 0 2
2 1 1
0 0 2
Enter the available Resources
3 2 2
Process  Allocation      Max     Available
P1         0 1 0        7 5 3   3 2 2
P2         2 0 0        3 2 2
P3         3 0 2        9 0 2
P4         2 1 1        2 2 2
P5         0 0 2        4 3 3
P1->P3->P4->P2->P0->
 The system is in safe state
```

```
********** Baner's Algo ************
Enter the no of Processes       3
Enter the no of resources instances     3
Enter the Max Matrix
3 6 8
4 3 3
3 4 4
Enter the Allocation Matrix
3 3 3
2 0 3
1 2 4
Enter the available Resources
1 2 0
Process  Allocation      Max     Available
P1         3 3 3        3 6 8   1 2 0
P2         2 0 3        4 3 3
P3         1 2 4        3 4 4
P0->P1->P2->
 Process are in dead lock
 System is in unsafe state
```

LAB PROGRAM 8

Write a C program to simulate deadlock detection.

```
#include<stdio.h>
static int mark[20];
int i, j, np, nr;
int main()
{
int alloc[10][10],request[10][10],avail[10],r[10],w[10];
printf ("\nEnter the no of the 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]);
```

```
/*Available Resource calculation*/
for(j=0;j<nr;j++)
{
avail[j]=r[j];
for(i=0;i<np;i++)
{
avail[j]-=alloc[i][j];
}
}
//marking processes with zero allocation
for(i=0;i<np;i++)
{
int count=0;
 for(j=0;j<nr;j++)
   {
      if(alloc[i][j]==0)
        count++;
      else
        break;
    }
 if(count==nr)
 mark[i]=1;
}
// initialize W with avail
for(j=0;j<nr; j++)
    w[j]=avail[j];
```

```
//mark processes with request less than or equal to W
for(i=0;i<np; i++)
{
int canbeprocessed= 0;
 if(mark[i]!=1)
{
  for(j=0;j<nr;j++)
   {
     if(request[i][j]<=w[j])
       canbeprocessed=1;
     else
       {
       canbeprocessed=0;
       break;
        }
    }
if(canbeprocessed)
{
mark[i]=1;
for(j=0;j<nr;j++)
w[j]+=alloc[i][j];
}
}
}
//checking for unmarked processes
int deadlock=0;
```

```
for(i=0;i<np;i++)
if(mark[i]!=1)
deadlock=1;
if(deadlock)
printf("\n Deadlock detected");
else
printf("\n No Deadlock possible");
}
```

OUTPUT:

```
Enter the no of the process: 4

Enter the no of resources: 5

Total Amount of the Resource R  1: 2

Total Amount of the Resource R  2: 1

Total Amount of the Resource R  3: 1

Total Amount of the Resource R  4: 2

Total Amount of the Resource R  5: 1

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

Enter the allocation matrix:1 0 1 1 0
1 1 0 0 0
0 0 0 1 0
0 0 0 0 0

 Deadlock detected
```

```
Enter the no of the process: 3

Enter the no of resources: 3

Total Amount of the Resource R  1: 1

Total Amount of the Resource R  2: 2

Total Amount of the Resource R  3: 4

Enter the request matrix:1 0 2
2 0 9
1 1 0

Enter the allocation matrix:0 0 1
1 3 6
9 5 1

 Deadlock detected
```

LAB PROGRAM 9

Write a C program to simulate the following contiguous memory allocation techniques.

- Worst-fit
- Best-fit
- First-fit

Worst-fit:

```
#include <stdio.h>
#include <string.h>
// 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];
    // Initially no block is assigned to any process
    memset(allocation, -1, sizeof(allocation));
    // pick each process and find suitable blocks
    // according to its size and assign to it
    for (int i = 0; i < n; i++)
    {
        // Find the best fit block for the current process
        int wstIdx = -1;
        for (int 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 the 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];
    }
}
printf("\nProcess No.\tProcess Size\tBlock no.\n");
for (int i = 0; i < n; i++)
{
    printf(" %d\t\t%d\t\t", i + 1, processSize[i]);
    if (allocation[i] != -1)
        printf("%d", allocation[i] + 1);
    else
        printf("Not Allocated");
```

```
        printf("\n");
    }
}
// Driver code
int main()
{
    int blockSize[] = {100, 500, 200, 300, 600};
    int processSize[] = {212, 417, 112, 426};
    int m = sizeof(blockSize) / sizeof(blockSize[0]);
    int n = sizeof(processSize) / sizeof(processSize[0]);
    worstFit(blockSize, m, processSize, n);
    return 0;
}
```

OUTPUT:

```
Process No.     Process Size    Block no.
 1              212             5
 2              417             2
 3              112             5
 4              426             Not Allocated
```

```
Process No.     Process Size    Block no.
 1              1               3
 2              4               3
```

Best-fit:

```
#include <stdio.h>
void implimentBestFit(int blockSize[], int blocks, int processSize[], int processes)
{
```

```
// This will store the block id of the allocated block to a process
int allocation[processes];
// initially assigning -1 to all allocation indexes
// means nothing is allocated currently
for(int i = 0; i < processes; i++){
   allocation[i] = -1;
}
 // pick each process and find suitable blocks
// according to its size ad assign to it
for (int i=0; i < processes; i++)
{
   int indexPlaced = -1;
   for (int j=0; j < blocks; j++)
   {
      if (blockSize[j] >= processSize[i])
      {
         // place it at the first block fit to accomodate process
         if (indexPlaced == -1)
            indexPlaced = j;
         // if any future block is better that is
         // any future block with smaller size encountered
         // that can accomodate the given process
         else if (blockSize[j] < blockSize[indexPlaced])
            indexPlaced = j;
      }
   }
```

```
        // If we were successfully able to find block for the process
        if (indexPlaced != -1)
        {
            // allocate this block j to process p[i]
            allocation[i] = indexPlaced;

            // Reduce available memory for the block
            blockSize[indexPlaced] -= processSize[i];
        }
    }
    printf("\nProcess No.\tProcess Size\tBlock no.\n");
    for (int i = 0; i < processes; i++)
    {
        printf("%d \t\t\t %d \t\t\t", i+1, processSize[i]);
        if (allocation[i] != -1)
            printf("%d\n",allocation[i] + 1);
        else
            printf("Not Allocated\n");
    }
}
// Driver code
int main()
{
    int blockSize[] = {50, 20, 100, 90};
    int processSize[] = {10, 30, 60, 80};
```

```
    int blocks = sizeof(blockSize)/sizeof(blockSize[0]);
    int processes = sizeof(processSize)/sizeof(processSize[0]);
    implimentBestFit(blockSize, blocks, processSize, processes);
    return 0 ;
}
```

OUTPUT:

```
Process No.     Process Size    Block no.
1                       10                      2
2                       30                      1
3                       60                      4
4                       80                      3
```

```
Process No.     Process Size    Block no.
1                       1                       2
2                       4                       1
```

First-fit:

```
#include <stdio.h>
void implimentFirstFit(int blockSize[], int blocks, int processSize[], int processes)
{
    // This will store the block id of the allocated block to a process
    int allocate[processes];
    // initially assigning -1 to all allocation indexes
    // means nothing is allocated currently
    for(int i = 0; i < processes; i++)
    {
                allocate[i] = -1;
    }
```

```
    // take each process one by one and find
    // first block that can accomodate it
    for (int i = 0; i < processes; i++)
    {
        for (int j = 0; j < blocks; j++) {
            if (blockSize[j] >= processSize[i])
            {
                // allocate block j to p[i] process
                allocate[i] = j;
                // Reduce size of block j as it has accomodated p[i]
                blockSize[j] -= processSize[i];
                break;
            }
        }
    }
    printf("\nProcess No.\tProcess Size\tBlock no.\n");
    for (int i = 0; i < processes; i++)
    {
        printf("%d \t\t\t %d \t\t\t", i+1, processSize[i]);
        if (allocate[i] != -1)
            printf("%d\n",allocate[i] + 1);
        else
            printf("Not Allocated\n");
    }
}
```

```
void main()
{
   int blockSize[] = {30, 5, 10};
   int processSize[] = {10, 6, 9};
   int m = sizeof(blockSize)/sizeof(blockSize[0]);
   int n = sizeof(processSize)/sizeof(processSize[0]);
   implimentFirstFit(blockSize, m, processSize, n);
}
```

```
Process No.     Process Size    Block no.
1                       10                      1
2                       6                       1
3                       9                       1
```

```
Process No.     Process Size    Block no.
1                       1                       1
2                       4                       1
```

LAB PROGRAM 10

Write a C program to simulate page replacement algorithms

- FIFO
- LRU
- Optimal

FIFO:

```
#include<stdio.h>
int main()
{
   int i,j,n,a[50],frame[10],no,k,avail,count=0;
   printf("ENTER THE NUMBER OF PAGES: ");
   scanf("%d",&n);
   printf("\nENTER THE PAGE REFERENCE : ");
   for(i=1;i<=n;i++)
      scanf("%d",&a[i]);
   printf("\nENTER THE NUMBER OF FRAMES : ");
   scanf("%d",&no);
   for(i=0;i<no;i++)
      frame[i]= -1;
   j=0;
   printf("\tref string\t page frames\n");
   for(i=1;i<=n;i++)
   {
      printf("%d\t\t",a[i]);
      avail=0;
```

```
    for(k=0;k<no;k++)
       if(frame[k]==a[i])
          avail=1;
    if (avail==0)
    {
       frame[j]=a[i];
       j=(j+1)%no;
       count++;
       for(k=0;k<no;k++)
          printf("%d\t",frame[k]);
    }
    printf("\n");
  }
  printf("Page Fault Is %d",count);
  return 0;
}
```

OUTPUT:

```
ENTER THE NUMBER OF PAGES: 7

ENTER THE PAGE REFERENCE : 1 3 0 3 5 6 3

ENTER THE NUMBER OF FRAMES : 3
        ref string       page frames
1               1       -1      -1
3               1       3       -1
0               1       3       0
3
5               5       3       0
6               5       6       0
3               5       6       3
Page Fault Is 6
```

```
ENTER THE NUMBER OF PAGES: 14

ENTER THE PAGE REFERENCE : 7 0 1 2 0 3 0 4 2 3 0 3 2 3

ENTER THE NUMBER OF FRAMES : 4
        ref string       page frames
7               7       -1      -1      -1
0               7       0       -1      -1
1               7       0       1       -1
2               7       0       1       2
0
3               3       0       1       2
0
4               3       4       1       2
2
3
0               3       4       0       2
3
2
3
Page Fault Is 7
```

LRU:

```
#include<stdio.h>
void main()
{
   int q[20],p[50],c=0,c1,d,f,i,j,k=0,n,r,t,b[20],c2[20];
   printf("Enter no of pages: ");
   scanf("%d",&n);
   printf("Enter the reference string: ");
   for(i=0;i<n;i++)
      scanf("%d",&p[i]);
   printf("Enter no of frames: ");
   scanf("%d",&f);
   q[k]=p[k];
   printf("\n\t%d\n",q[k]);
   c++;
```

```
k++;
for(i=1;i<n;i++)
{
   c1=0;
   for(j=0;j<f;j++)
   {
      if(p[i]!=q[j])
         c1++;
   }
   if(c1==f)
   {
      c++;
      if(k<f)
      {
         q[k]=p[i];
         k++;
         for(j=0;j<k;j++)
            printf("\t%d",q[j]);
         printf("\n");
      }
      else
      {
         for(r=0;r<f;r++)
         {
            c2[r]=0;
            for(j=i-1;j<n;j--)
```

```
    {
        if(q[r]!=p[j])
            c2[r]++;
        else
            break;
    }
}
for(r=0;r<f;r++)
    b[r]=c2[r];
for(r=0;r<f;r++)
{
    for(j=r;j<f;j++)
    {
        if(b[r]<b[j])
        {
            t=b[r];
            b[r]=b[j];
            b[j]=t;
        }
    }
}
for(r=0;r<f;r++)
{
    if(c2[r]==b[0])
        q[r]=p[i];
    printf("\t%d",q[r]);
```

```
            }
            printf("\n");
        }
    }
  }
  printf("\nThe no of page faults is %d",c);
}
```

OUTPUT:

```
Enter no of pages: 10
Enter the reference string: 7 5 9 4 3 7 9 6 2 1
Enter no of frames: 3

        7
        7       5
        7       5       9
        4       5       9
        4       3       9
        4       3       7
        9       3       7
        9       6       7
        9       6       2
        1       6       2

The no of page faults is 10
```

```
Enter no of pages: 14
Enter the reference string: 7 0 1 2 0 3 0 4 2 3 0 3 2 3
Enter no of frames: 4

        7
        7       1
        7       1       2
        7       1       2       3
        0       1       2       3
        0       4       2       3

The no of page faults is 6
```

Optimal:

```
#include<stdio.h>
int main()
{
   int n,pg[30],fr[10];
   int count[10],i,j,k,fault,f,flag,temp,current,c,dist,max,m,cnt,p,x;
   fault=0;
   dist=0;
   k=0;
   printf("Enter the total no pages: ");
   scanf("%d",&n);
   printf("\nEnter the sequence: ");
   for(i=0;i<n;i++)
      scanf("%d",&pg[i]);
   printf("\nEnter frame size: ");
   scanf("%d",&f);
   for(i=0;i<f;i++)
   {
      count[i]=0;
      fr[i]=-1;
   }
   for(i=0;i<n;i++)
   {
      flag=0;
      temp=pg[i];
      for(j=0;j<f;j++)
```

```
{
   if(temp==fr[j])
   {
      flag=1;
      break;
   }
}
if((flag==0)&&(k<f))
{
   fault++;
   fr[k]=temp;
   k++;
}
else if((flag==0)&&(k==f))
{
   fault++;
   for(cnt=0;cnt<f;cnt++)
   {
      current=fr[cnt];
      for(c=i;c<n;c++)
      {
         if(current!=pg[c])
            count[cnt]++;
         else
            break;
      }
```

```
            }
            max=0;
            for(m=0;m<f;m++)
            {
               if(count[m]>max)
               {
                  max=count[m];
                  p=m;
               }
            }
            fr[p]=temp;
         }
         printf("\npage  %d  frame\t",pg[i]);
         for(x=0;x<f;x++)
         {
            printf("%d\t",fr[x]);
         }
      }
      printf("\nTotal number of faults= %d",fault);
      return 0;
}
```

OUTPUT:

```
Enter the total no pages: 10

Enter the sequence: 0 1 2 3 0 1 2 3 0 1

Enter frame size: 3

page  0  frame  0       -1      -1
page  1  frame  0       1       -1
page  2  frame  0       1       2
page  3  frame  0       1       3
page  0  frame  0       1       3
page  1  frame  0       1       3
page  2  frame  0       2       3
page  3  frame  0       2       3
page  0  frame  0       2       3
page  1  frame  0       1       3
Total number of faults= 6
```

```
Enter the total no pages: 14

Enter the sequence: 7 0 1 2 0 3 0 4 3 2 0 3 2 3

Enter frame size: 4

page  7  frame  7       -1      -1      -1
page  0  frame  7       0       -1      -1
page  1  frame  7       0       1       -1
page  2  frame  7       0       1       2
page  0  frame  7       0       1       2
page  3  frame  3       0       1       2
page  0  frame  3       0       1       2
page  4  frame  3       0       4       2
page  3  frame  3       0       4       2
page  2  frame  3       0       4       2
page  0  frame  3       0       4       2
page  3  frame  3       0       4       2
page  2  frame  3       0       4       2
page  3  frame  3       0       4       2
Total number of faults= 6
```

LAB PROGRAM 11

Write a C program to simulate disk scheduling algorithms

- FCFS
- SCAN
- C-SCAN

FCFS:

```
#include<stdio.h>
#include<stdlib.h>
int main()
{
   int RQ[100],i,n,TotalHeadMoment=0,initial;
   printf("Enter the number of Requests: ");
   scanf("%d",&n);
   printf("\nEnter the Requests sequence: ");
   for(i=0;i<n;i++)
    scanf("%d",&RQ[i]);
   printf("\nEnter initial head position: ");
   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: 95 180 34 119 11 123 62 64

Enter initial head position: 50
Total head moment is 644
```

```
Enter the number of Requests: 7

Enter the Requests sequence: 82
170
43
140
24
16
190

Enter initial head position: 50
Total head moment is 642
```

SCAN:

```
#include <stdio.h>
int request[50];
int SIZE;
int pre;
int head;
int uptrack;
int downtrack;
struct max{
   int up;
   int down;
} kate[50];
int dist(int a, int b){
   if (a > b)
```

```
        return a - b;
    return b - a;
}
void sort(int n){
    int i, j;
    for (i = 0; i < n - 1; i++){
        for (j = 0; j < n - i - 1; j++){
            if (request[j] > request[j + 1]){
                int temp = request[j];
                request[j] = request[j + 1];
                request[j + 1] = temp;
            }
        }
    }
    j = 0;
    i = 0;
    while (request[i] != head){
        kate[j].down = request[i];
        j++;
        i++;
    }
    downtrack = j;
    i++;
    j = 0;
    while (i < n){
        kate[j].up = request[i];
```

```
        j++;
        i++;
    }
    uptrack = j;
}
void scan(int n){
    int i;
    int seekcount = 0;
    printf("SEEK SEQUENCE = ");
    sort(n);
    if (pre < head){
        for (i = 0; i < uptrack; i++){
            printf("%d ", head);
            seekcount = seekcount + dist(head, kate[i].up);
            head = kate[i].up;
        }
        for (i = downtrack - 1; i > 0; i--){
            printf("%d ", head);
            seekcount = seekcount + dist(head, kate[i].down);
            head = kate[i].down;
        }
    }
    else{
        for (i = downtrack - 1; i >= 0; i--){
            printf("%d ", head);
            seekcount = seekcount + dist(head, kate[i].down);
```

```
            head = kate[i].down;
        }
        for (i = 0; i < uptrack - 1; i++){
            printf("%d ", head);
            seekcount = seekcount + dist(head, kate[i].up);
            head = kate[i].up;
        }
    }
    printf(" %d\nTOTAL DISTANCE :%d", head, seekcount);
}
int main(){
    int n, i;
    printf("ENTER THE DISK SIZE : ");
    scanf("%d", &SIZE);
    printf("\nENTER THE NO OF REQUEST SEQUENCE : ");
    scanf("%d", &n);
    printf("\nENTER THE REQUEST SEQUENCE : ");
    for (i = 0; i < n; i++)
        scanf("%d", &request[i]);
    printf("\nENTER THE CURRENT HEAD : ");
    scanf("%d", &head);
    request[n] = head;
    request[n + 1] = SIZE - 1;
    request[n + 2] = 0;
    printf("\nENTER THE PRE REQUEST : ");
    scanf("%d", &pre);
```

```
    scan(n + 3);
}
```

OUTPUT:

```
ENTER THE DISK SIZE : 4

ENTER THE NO OF REQUEST SEQUENCE : 2

ENTER THE REQUEST SEQUENCE : 1 2

ENTER THE CURRENT HEAD : 1

ENTER THE PRE REQUEST : 2
SEEK SEQUENCE = 1 0 1  2
TOTAL DISTANCE :3
```

```
ENTER THE DISK SIZE : 200

ENTER THE NO OF REQUEST SEQUENCE : 7

ENTER THE REQUEST SEQUENCE : 82
170
43
140
24
16
190

ENTER THE CURRENT HEAD : 50

ENTER THE PRE REQUEST : 1
SEEK SEQUENCE = 50 82 140 170 190 199 43 24  16
TOTAL DISTANCE :332
```

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: ");
    scanf("%d", &n);
    printf("\nEnter the Requests sequence: ");
```

```
for (i = 0; i < n; i++)
   scanf("%d", &RQ[i]);
printf("\nEnter initial head position: ");
scanf("%d", &initial);
printf("\nEnter total disk size: ");
scanf("%d", &size);
printf("\nEnter the head movement direction for high 1 and for low 0: ");
scanf("%d", &move);
for (i = 0; i < n; i++){
   for (j = 0; j < n - i - 1; j++){
      if (RQ[j] > RQ[j + 1]){
         int temp;
         temp = RQ[j];
         RQ[j] = RQ[j + 1];
         RQ[j + 1] = temp;
      }
   }
}
int index;
for (i = 0; i < n; i++){
   if (initial < RQ[i]){
      index = i;
      break;
   }
}
if (move == 1){
```

```
    for (i = index; i < n; i++){
        TotalHeadMoment = TotalHeadMoment + abs(RQ[i] - initial);
        initial = RQ[i];
    }
    TotalHeadMoment = TotalHeadMoment + abs(size - RQ[i - 1] - 1);
    TotalHeadMoment = TotalHeadMoment + abs(size - 1 - 0);
    initial = 0;
    for (i = 0; i < index; i++){
        TotalHeadMoment = TotalHeadMoment + abs(RQ[i] - initial);
        initial = RQ[i];
    }
}
else{
    for (i = index - 1; i >= 0; i--){
        TotalHeadMoment = TotalHeadMoment + abs(RQ[i] - initial);
        initial = RQ[i];
    }
    TotalHeadMoment = TotalHeadMoment + abs(RQ[i + 1] - 0);
    TotalHeadMoment = TotalHeadMoment + abs(size - 1 - 0);
    initial = size - 1;
    for (i = n - 1; i >= index; i--){
        TotalHeadMoment = TotalHeadMoment + abs(RQ[i] - initial);
        initial = RQ[i];
    }
}
printf("Total head movement is %d", TotalHeadMoment);
```

```
    return 0;
}
```

OUTPUT:

```
Enter the number of Requests: 7

Enter the Requests sequence: 82
170
43
140
24
16
190

Enter initial head position: 50

Enter total disk size: 200

Enter the head movement direction for high 1 and for low 0: 0
Total head movement is 366
```

```
Enter the number of Requests: 3

Enter the Requests sequence: 2 1 0

Enter initial head position: 1

Enter total disk size: 3

Enter the head movement direction for high 1 and for low 0: 1
Total head movement is 4
```