VISVESVARAYA TECHNOLOGICAL UNIVERSITY

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LAB REPORT

on

OPERATING SYSTEMS

Submitted by

SUSHANTH C (1WA23CS001)

in partial fulfillment for the award of the degree of

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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 SYSTEMS – 23CS4PCOPS" carried out by Sushanth C(1WA23CS001), who is Bonafide student of B. M. S. College of Engineering. It is in partial fulfilment for the award of Bachelor of Engineering in Computer Science and Engineering of the Visvesvaraya Technological University, Belgaum during the year Feb 2025- June 2025. The Lab report has been approved as it satisfies the academic requirements in respect of a OPERATING SYSTEMS - (23CS4PCOPS) work prescribed for the said degree.

Dr.Sema Patil
Assistant Professor
Department of CSE
BMSCE, Bengaluru

Dr. Kavitha Sooda
Professor and Head
Department of CSE
BMSCE, Bengaluru

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Course Outcomes

C01	Apply the different concepts and functionalities of Operating System
C02	Analyse various Operating system strategies and techniques
C03	Demonstrate the different functionalities of Operating System.
C04	Conduct practical experiments to implement the functionalities of Operating system.

Name SUSHANTH.C Std Sec

Roll No. Subject OS (OBSERVATION) School/College

School/College Tel. No. Parents Tel. No.

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10		Producer - Consumer		10/10
11		Dining Philosopher		
12		Banker's algorithm		10/10
13		Deadlock detection		
14		Deadlock Avoidance		
15.		Memory Management Unit scheme (Best Fit / Worst fit)		10/10
16.		FIFO		10/10

Completed

Program -1

Question:

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

→FCFS

→ SJF (pre-emptive & Non-preemptive)

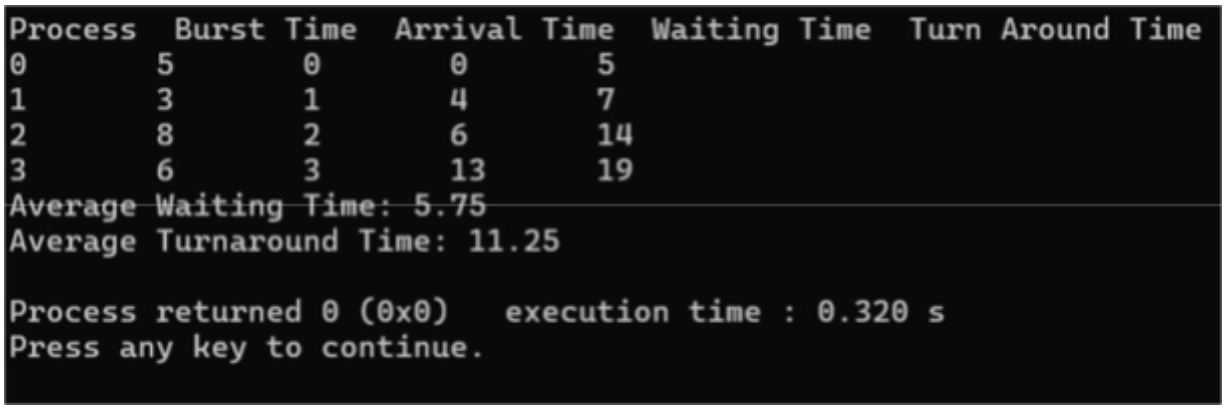
Code:

=>FCFS:

```
#include<stdio.h>

void sort(int proc_id[],int at[],int bt[],int n)
{    int
min=at[0],temp=0;
for(int i=0;i<n;i++)
   {
min=at[i];
       for(int j=i;j<n;j++)
       {
if(at[j]<min)
          {              temp=at[i];
at[i]=at[j];
at[j]=temp;
temp=bt[j];
bt[j]=bt[i];
bt[i]=temp;
temp=proc_id[i];
proc_id[i]=proc_id[j];
proc_id[j]=temp;
          }
       }
   }
}

void main()
{    int n,c=0;    printf("Enter number
of processes: ");    scanf("%d",&n);
int
proc_id[n],at[n],bt[n],ct[n],tat[n],wt[n];
double
```

```
avg_tat=0.0,ttat=0.0,avg_wt=0.0,twt=0.
0;     for(int i=0;i<n;i++)
proc_id[i]=i+1;     printf("Enter arrival
times:\n");     for(int i=0;i<n;i++)
scanf("%d",&at[i]);     printf("Enter
burst times:\n");     for(int i=0;i<n;i++)
scanf("%d",&bt[i]);

   sort(proc_id,at,bt,n);
//completion time     for(int
i=0;i<n;i++)
   {        if(c>=at[i])
c+=bt[i];        else
c+=at[i]-ct[i-1]+bt[i];
ct[i]=c;
   }
   //turnaround time
for(int i=0;i<n;i++)
tat[i]=ct[i]-at[i];
//waiting time     for(int
i=0;i<n;i++)
wt[i]=tat[i]-bt[i];

   printf("FCFS scheduling:\n");     printf("PID\tAT\tBT\tCT\tTAT\tWT\n");
for(int i=0;i<n;i++)
printf("%d\t%d\t%d\t%d\t%d\t%d\n",proc_id[i],at[i],bt[i],ct[i],tat[i],wt[i]);

   for(int i=0;i<n;i++)
   {
ttat+=tat[i];twt+=wt[i];
   }
   avg_tat=ttat/(double)n;     avg_wt=twt/(double)n;
printf("\nAverage turnaround time:%lfms\n",avg_tat);
printf("\nAverage waiting time:%lfms\n",avg_wt);
}
```

Result:


Process Burst Time Arrival Time Waiting Time Turn Around Time
0 5 0 0 5
1 3 1 4 7
2 8 2 6 14
3 6 3 13 19
Average Waiting Time: 5.75
Average Turnaround Time: 11.25
Process returned 0 (0x0) execution time : 0.320 s
Press any key to continue.

First come first serve

```
#include <stdio.h>
int main () {
 int n;
 printf ("no of process : ");
 scanf ("%d", &n);
  int arrivalTime (n);
  int completion Time (n);
  int TurnAround Time (n);
  int Waiting Time (n);
 ~~pf (" Arrival time ; i<n ; i++ ) {~~
 pf("Arrival Time of each process :");
 for (int i= 0; i<n ; i++)
    {
      scanf ("%d", &Arrival Time [i]);
    }
 printf (" Burst Time of each process : ");
 for (int i=0 ; i<n ; i++) {
   scanf ("%d", & Burst Time [i]);
  }
  int sum = 0
  for (int i=0; i <n ; i++) {
     sum+ = Burst Time [i];
     Completion Time [i] = Sum ;
  }
  for (int i=0; i<n ; i++) {
     Turn Around Time [i] = CT[i] - AT [i]
  }
  for (int i=0 ; i<n ; i++) {
    waiting [i] : Turn Around [i] - Burst (i)
```

float CT, TAT, WT;

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

WT += waiting Time (i);

CT += Completion Time (i);

TAT += Turn Around Time (i);

}

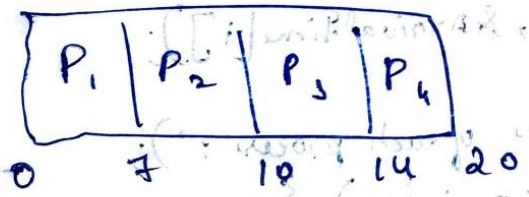
WT = n;

CT = n;

TAT = n;

printf (" CT : %f \n TAT : \n WT : %f", CT, TAT, WT);

Gantt Chart



Output

no of process : 4

AT of each process : 0 0 0 0

BT of each process : 7 3 4 6

CT : 12.750000

TAT : 12.750000

WT : 7.750000

SJF(NON PREEMPITIVE) CODE:

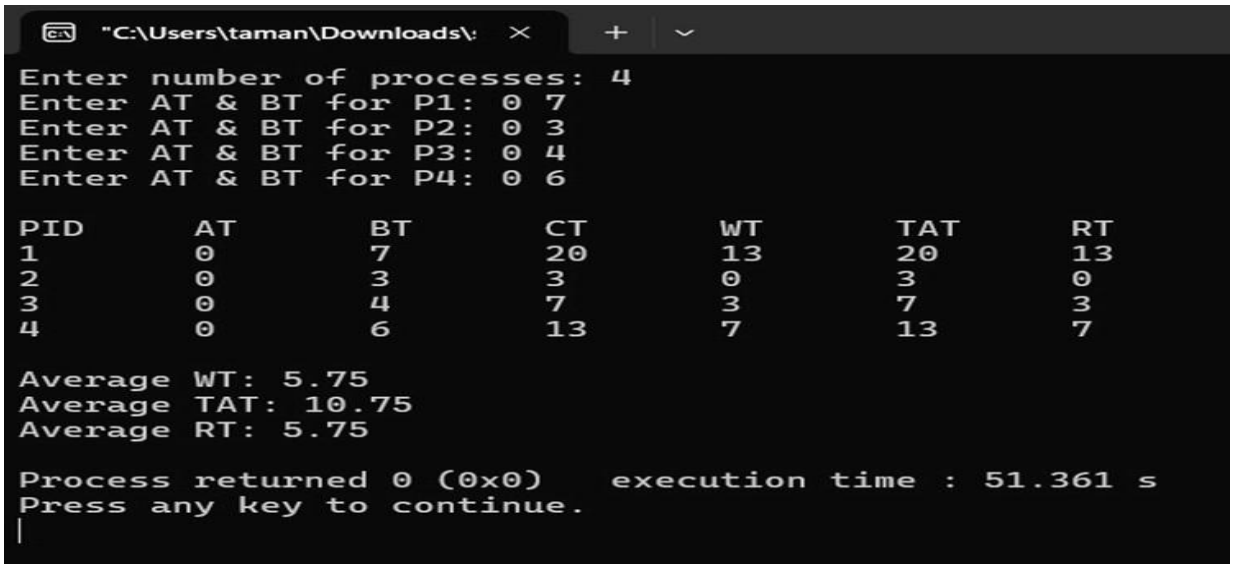
```
#include <stdio.h> struct Process

{

int pid, bt, at, wt, tat, rt, ct;

};

void sortByArrival(struct Process p[], int n) {

for (int i = 0; i < n - 1; i++) {

for (int j = 0; j < n - i - 1; j++)

 {

if (p[j].at > p[j + 1].at)

{

struct Process temp = p[j];

        p[j] = p[j + 1];

p[j + 1] = temp;

        }

           }

        }

}

void sjfScheduling(struct Process p[], int n) {
```

```
        sortByArrival(p, n);
int completed = 0, currentTime = 0;
int totalWT = 0, totalTAT = 0, totalRT = 0;
while (completed < n) {
int minIndex = -1, minBT = 9999;
for (int i = 0; i < n; i++) {
if (p[i].at <= currentTime && p[i].bt <
minBT && p[i].tat == 0)
{
minBT = p[i].bt;
        minIndex = i;
        }
        }
        if (minIndex == -1) {
currentTime++;          continue;
        }
        p[minIndex].wt = currentTime - p[minIndex].at;
p[minIndex].tat = p[minIndex].wt + p[minIndex].bt;
p[minIndex].rt = p[minIndex].wt;
```

```
        p[minIndex].ct = currentTime + p[minIndex].bt;
currentTime += p[minIndex].bt;        completed++;

        totalWT += p[minIndex].wt;
totalTAT += p[minIndex].tat;
totalRT += p[minIndex].rt;
        }
   printf("\nPID\tAT\tBT\tCT\tWT\tTAT\tRT\n");
for (int i = 0; i < n; i++) {
        printf("%d\t%d\t%d\t%d\t%d\t%d\t%d\n", p[i].pid, p[i].at, p[i].bt, p[i].ct, p[i].wt, p[i].tat,
p[i].rt);
        }
        printf("\nAverage WT: %.2f", (float)totalWT / n);
printf("\nAverage TAT: %.2f", (float)totalTAT / n);   printf("\nAverage RT:
%.2f\n", (float)totalRT / n);
} int main()
{
        int n;
        printf("Enter number of processes: ");
scanf("%d", &n);        struct Process p[n];     for
```

```
(int i = 0; i < n; i++) {          printf("Enter AT &
BT for P%d: ", i + 1);             scanf("%d %d",
&p[i].at, &p[i].bt);               p[i].pid = i + 1;
p[i].wt = p[i].tat = p[i].rt = p[i].ct = 0;
        }
        sjfScheduling(p, n);
return 0;
}
```

Output:



4. Priority (~~preemption~~)
shortest job first (Non - preemptive)

```
#include <stdio.h>
typedef struct {
    int pid, at, bt, rema
} process;

void swap (process *a, Process* b){
    *a=*b;
    *b = temp;
}
void sortbyarrival(Process process[], i, int n)
{
  for( int i=0; i<n; i++)
  {
    for (int j=0; j<n-i-1; j++)
    {
      if((( procss[j].arrival time > process[j+1]
        .at ) || (process[j].at == process[j+1].
          at && process[j].priority >
              process[j+1].priority)) {
        swap (&process[j], &process[j+1]
      }
    }
  }
}
void priority_preemptive_scheduling(process processs[]
  int n) {
  int completedno=0, currenttime=0, min_priority,
  isselected=0;
```

```
for (int i=0; i<n; i++)
{
    processes[i].remaining_time = process[i].burst_time;
}
while (completed != n) {
    min_priority = 9999;
    selected = -1;
    for (int i=0; i<n; i++) {
        if (process[i].at <= ct && process[i]..
        remaining_time > 0 {
        if (process[i].priority < min_priority{
            min_priority = process[i].priority;
            selected = i;
        }
    }
}
if (selected == -1) {
    current_time++;
    continue;
}
process[selected].remaining_time--;
current_time++;
process(selected).PT--;
current_Time++;
if (process(selected).RT == 0) {
    completed++;
    processes(selected).Turnaround_time
    = process(selected).completion_time
```

(selected).arrivaltime;

processes(selected).waiting_time=
processes(selected).
TA - processe

(selected).BT;

process(selected).WT = process(selected).
TA - process(selected).BT

}
}

Output

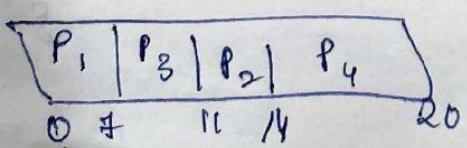
no of process : 4

BT 1: 7
AT 1: 0
BT 2: 3
AT 2: 2
BT 3: 4
AT 3: 2
BT 4: 6
AT 4: 5

Avg WT = 4.00
Avg TAT: 9.00

P	AT	BT	CT	TAT	WT	RT
P_1	0	7	7	7	0	0
P_2	2	3	14	6	3	3
P_3	3	4	11	8	4	5
P_4	5	6	20	15	9	9

Ay: 9 Avg: 4

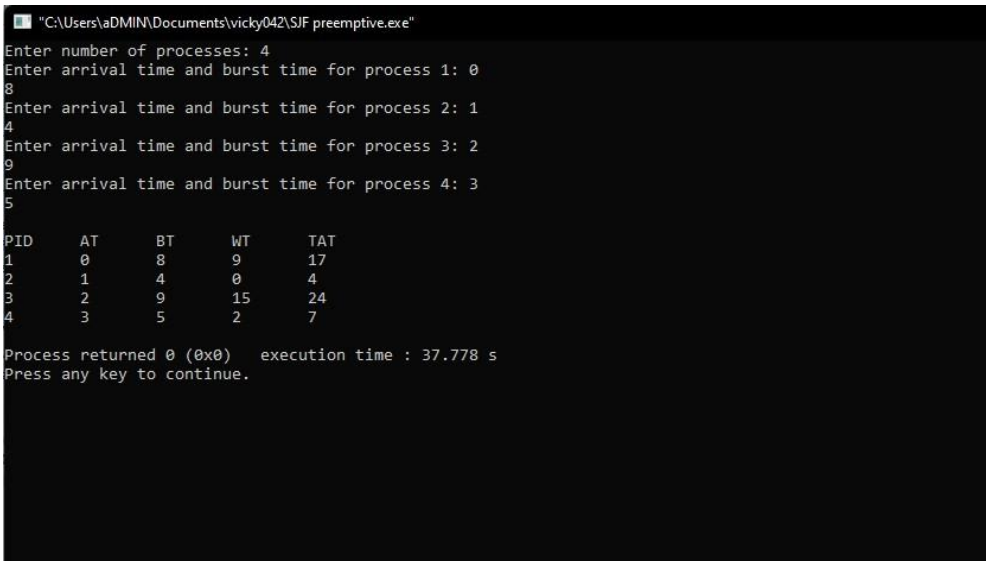


#include

Preemptive Shortest Job First (SJF)

```
include<stdio.h>

#define MAX 10

typedef struct {
   int pid, at, bt, rt, wt, tat, completed;
} Process;

void sjf_preemptive(Process p[], int n) {     int time = 0,
completed = 0, shortest = -1, min_bt = 9999;

   while (completed < n) {
shortest = -1;         min_bt
= 9999;

      for (int i = 0; i < n; i++) {
         if (p[i].at <= time && p[i].rt > 0 && p[i].rt < min_bt) {
min_bt = p[i].rt;                shortest = i;
         }
      }

      if (shortest == -1) {
time++;            continue;
      }

      p[shortest].rt--;
time++;

      if (p[shortest].rt == 0) {
p[shortest].completed = 1;            completed++;
```

```
            p[shortest].tat = time - p[shortest].at;
p[shortest].wt = p[shortest].tat - p[shortest].bt;
        }
    }
}

int main() {
Process p[MAX];
    int n;

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

    for (int i = 0; i < n; i++) {
p[i].pid = i + 1;
        printf("Enter arrival time and burst time for process %d: ", p[i].pid);
scanf("%d %d", &p[i].at, &p[i].bt);         p[i].rt = p[i].bt;
p[i].completed = 0;
    }

    sjf_preemptive(p, n);

    printf("\nPID\tAT\tBT\tWT\tTAT\n");
for (int i = 0; i < n; i++)
        printf("%d\t%d\t%d\t%d\t%d\n", p[i].pid, p[i].at, p[i].bt, p[i].wt, p[i].tat);

    return 0;
}
```


"C:\Users\aDMIN\Documents\vicky042\SJF preemptive.exe"
Enter number of processes: 4
Enter arrival time and burst time for process 1: 0
8
Enter arrival time and burst time for process 2: 1
4
Enter arrival time and burst time for process 3: 2
9
Enter arrival time and burst time for process 4: 3
5
PID AT BT WT TAT
1 0 8 9 17
2 1 4 0 4
3 2 9 15 24
4 3 5 2 7
Process returned 0 (0x0) execution time : 37.778 s
Press any key to continue.

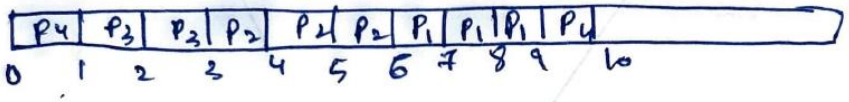
SJFC (Preemptive)

```
#include <stdio.h>
struct Process {
int id ; int BT ; int AT ; int CT ; int ST ;
} ;
int compareAT (const void *a , void *b)
{
return ((struct Process *)) a -> AT - ST (b) AT
}
int compare RT (const void *a , const void *b)
{ return ((struct Process* ))a -> AT - St(b) AT
}
int compare RT (const void *a , const void *b)
{ return ((struct Process *)a) -> RT ((struct
Process) , compare AT) ;
while (completed Processes < num Process) {
int index = -1 ;
for (int i = 0 ; i) < num Proces ; i++) {
if (process (i) - at 2 = (T && proces (i). RT > 0)
{ if (process (i) - at 2 = CT && process (i). RT > 0)
{ if (mini index = = -1)
min Index = i ;
}
}
```

```
if (minIndex == -1) {
    CT;
    continue;
}
if (processes[minIndex].RT == 0) {
    processes[minIndex].RT = currentTime;
    completedProcesses++;
}
pf("Processes Completed");
}
int main() {
    struct Process(maxProcesses);
    int numProcesses;
    for(int i=0; i<numProcesses; i++) {
        processes(i).id = i+1;
    pf("Enter AT");
    sf("%d", &process(i).BT);
    process(i).RT = process(i).BT;
    preemptiveSTF(processes, numProcesses);
}
```

Problem :-

			CT	TAT	WT	RT
P_1	0	4	17	17	9	0
P_2	1	3	5	4	0	0
P_3	0	2	26	24	15	15
P_4	0	1	10	7	2	2

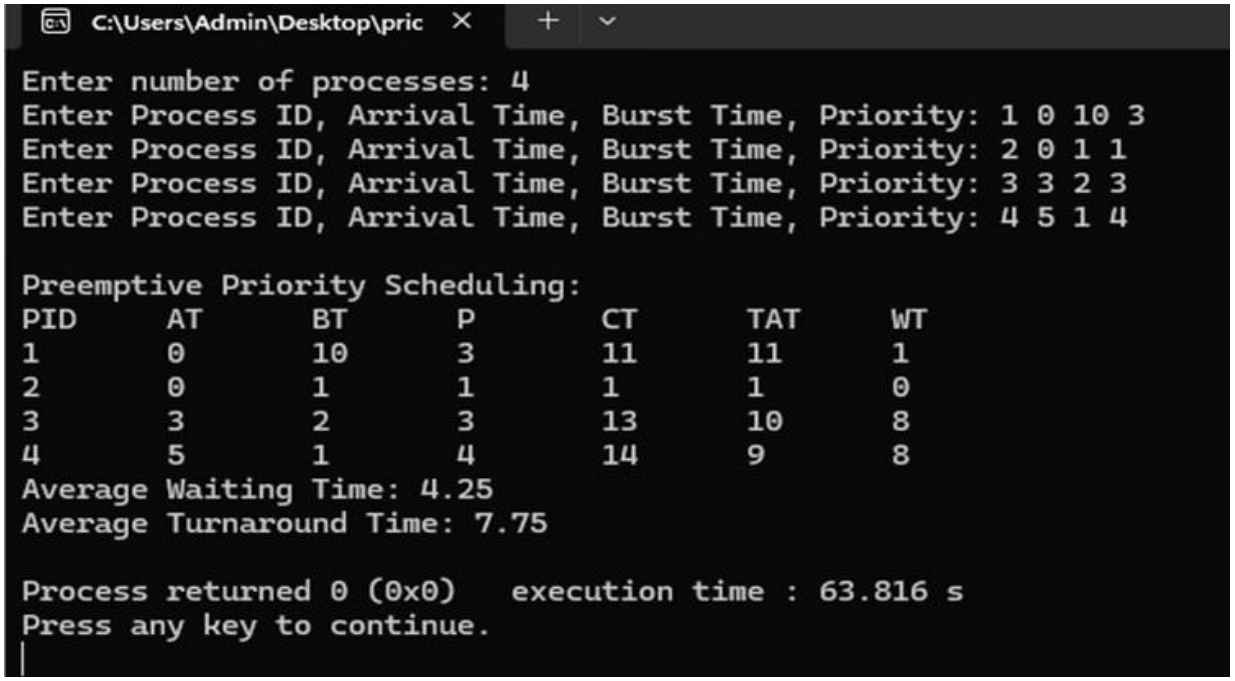


PRIORITY SCHEDULING (PREEMPTIVE)

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

struct Process {
   int pid, at, bt, pr, ct, wt, tat, rt, remaining;
};

void findPreemptivePriorityScheduling(struct Process p[], int n) {
int completed = 0, time = 0, min_idx = -1;     float totalWT = 0,
totalTAT = 0;

   for (int i = 0; i < n; i++) {
p[i].remaining = p[i].bt;         p[i].rt
= -1;
   }

   while (completed != n) {         int
min_priority = INT_MAX;
min_idx = -1;

      for (int i = 0; i < n; i++) {
         if (p[i].at <= time && p[i].remaining > 0 && p[i].pr < min_priority) {
min_priority = p[i].pr;                min_idx = i;
         }
      }

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

```
        if (p[min_idx].rt == -1) {
p[min_idx].rt = time - p[min_idx].at;
        }

        p[min_idx].remaining--;
time++;

        if (p[min_idx].remaining == 0) {
completed++;             p[min_idx].ct =
time;
            p[min_idx].tat = p[min_idx].ct - p[min_idx].at;
p[min_idx].wt = p[min_idx].tat - p[min_idx].bt;
totalWT += p[min_idx].wt;             totalTAT +=
p[min_idx].tat;
        }
    }

    printf("PID\tAT\tBT\tPR\tCT\tTAT\tWT\tRT\n");
for (int i = 0; i < n; i++) {
        printf("%d\t%d\t%d\t%d\t%d\t%d\t%d\t%d\n",
              p[i].pid, p[i].at, p[i].bt, p[i].pr, p[i].ct, p[i].tat, p[i].wt, p[i].rt);
    }

    printf("\nAverage Turnaround Time: %.2f\n", totalTAT / n);
printf("Average Waiting Time: %.2f\n", totalWT / n);
}

int main() {
int n;
    printf("Enter the number of processes: ");
    scanf("%d", &n);
struct Process p[n];
```

```
    printf("Enter Arrival Time, Burst Time, and Priority for each process:\n");
for (int i = 0; i < n; i++) {        p[i].pid = i + 1;
        printf("Process %d: ", i + 1);
        scanf("%d %d %d", &p[i].at, &p[i].bt, &p[i].pr);
    }

    findPreemptivePriorityScheduling(p, n);
return 0;
}
```



Priority & preemtive

```
#include <stdio.h>
#include <stdlib.h>
struct Process {
  int id;
  int bt;
  int at;
  int ct;
  int tat;
  int wt;
};
int compareArrivalTime (const void *a, const void *b)
{
return ((struct Process *)a) -> at - ((struct
  Process *) b) -> at;
  }
void calculateTimes (struct Process processes[], int n)
 {
 int time = 0;
 int completed = 0;
 while (completed < n) {
 int shortest = -1;
 int min_burst = 1000000;
 for (int i = 0; i < n; i++) {
 if (processed[i].at <= min_burst) {
  min_burst = processes[i].bt;
     shortest = i;
  }
}
}
```

```
if (shortest == -1) {
    time ++;
} else {
    processes[shortest].ct = time + processes[shortest].bt;
    processes[shortest].tat = processes[shortest].ct;
    time = processes[shortest].ct;
    completed ++;
}
}
}

void calculateAvg (struct Process processes[],
    int n) {
    int total_wt = 0, total_tat = 0;
    for (int i = 0; i < n; i++) {
        total_wt += processes[i].wt;
        total_tat += processes[i].tat;
    }
    printf("\navg wt = %.2f", (float) total_tat/n);
    printf("\navg tat = %.2f", (float) total_tat/n);
}

int main() {
    int n;
    printf("no of processes:");
    scanf("%d", &n);
    struct Process processes[n];
    printf("enter bt and at: \n");
    for (int i = 0; i < n; i++) {
        processes[i].id = i+1;
        printf("bt %d: ", i+1);
        scanf("%d", &processes[i].bt);
        printf("at %d: ", i+1);
```

```
scanf("%d", &processes[i].at);
processes[i].ct = 0;
}
qsort(processes, n, sizeof(struct Process),
      compareArrivalTime);
calculateTime(processes, n);
calculateAvg(processes, n);
return 0;
}
```

Output

Process	AT	BT	PS	BT	CT	TAT	WT	RT
P_1	0	3	5	3	3	3	0	0
P_2	2	3	3	11	9	7	4	4
P_3	3	5	2	8	5	2	0	0
P_4	4	4	4	15	11	7	3	3
P_5	6	1	1	9	3	2	1	1

P_1	P_3	P_5	P_2	P_4
0	3	8	9	11	15

Enter the no of processes:

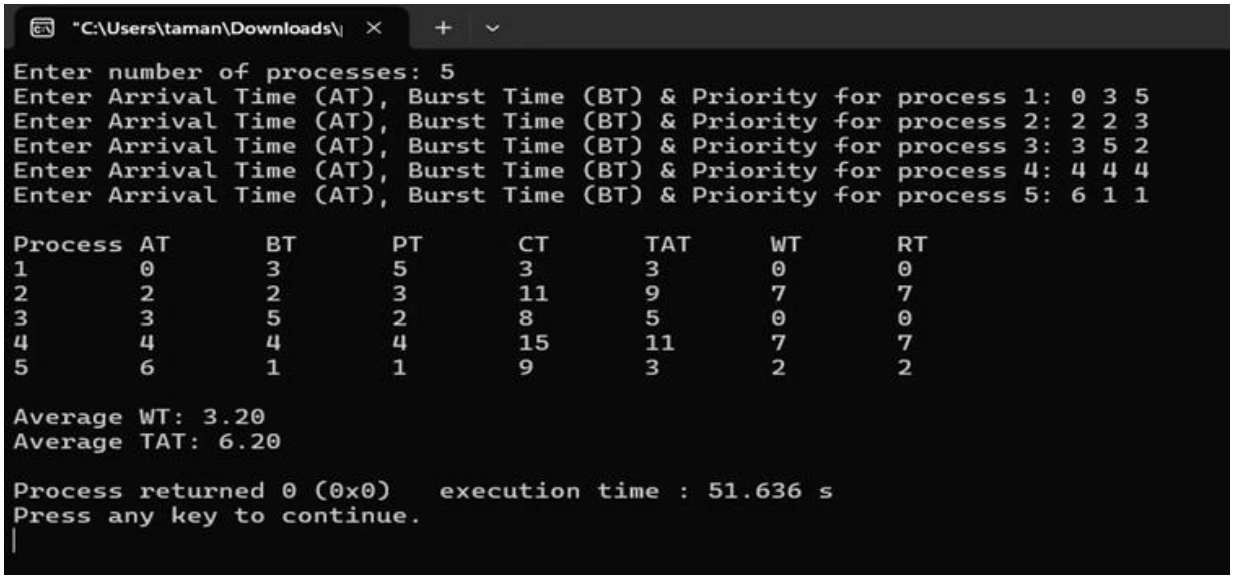
Enter the burst time for each process for each

PRIORITY SCHEDULING (NON PREEMPTIVE)

```
#include <stdio.h>

struct Process {
   int pid, at, bt, pr, ct, wt, tat, rt;
   int isCompleted; // Flag to check if process is completed
};

void sortByArrival(struct Process p[], int n) {
for (int i = 0; i < n - 1; i++) {         for (int j =
i + 1; j < n; j++) {             if (p[i].at > p[j].at)
{                 struct Process temp = p[i];
p[i] = p[j];                  p[j] = temp;
          }
       }
   }
}

void findPriorityScheduling(struct Process p[], int n) {
sortByArrival(p, n);     int time = 0, completed = 0;
float totalWT = 0, totalTAT = 0;

   while (completed < n) {         int idx =
-1, highestPriority = 9999;

       for (int i = 0; i < n; i++) {
          if (p[i].at <= time && p[i].isCompleted == 0) {
if (p[i].pr < highestPriority) {
                 highestPriority = p[i].pr;
idx = i;
             }
          }
```

```
        }

        if (idx == -1) {
time++; // CPU idle
        } else {
            p[idx].rt = time - p[idx].at;
time += p[idx].bt;              p[idx].ct =
time;              p[idx].tat = p[idx].ct -
p[idx].at;              p[idx].wt = p[idx].tat -
p[idx].bt;              p[idx].isCompleted =
1;

            totalWT += p[idx].wt;
totalTAT += p[idx].tat;
completed++;
        }
    }

    printf("PID\tAT\tBT\tPR\tCT\tTAT\tWT\tRT\n");
for (int i = 0; i < n; i++) {
        printf("%d\t%d\t%d\t%d\t%d\t%d\t%d\t%d\n",
                p[i].pid, p[i].at, p[i].bt, p[i].pr, p[i].ct, p[i].tat, p[i].wt, p[i].rt);
}

    printf("\nAverage Turnaround Time: %.2f\n", totalTAT / n);
printf("Average Waiting Time: %.2f\n", totalWT / n);
}

int main() {
int n;
    printf("Enter the number of processes: ");
scanf("%d", &n);      struct Process p[n];
```

```
    printf("Enter Arrival Time, Burst Time, and Priority for each process:\n");
for (int i = 0; i < n; i++) {        p[i].pid = i + 1;
        printf("Process %d: ", i + 1);
        scanf("%d %d %d", &p[i].at, &p[i].bt, &p[i].pr);
p[i].isCompleted = 0;
    }

    findPriorityScheduling(p, n);
return 0;
}
```



```
        temp = process[i];
        process[i] = process[j];
        process[j] = temp;
    }
  }
}
wait[0] = 0;
completion[0] = burst[0];
turnaround[0] = completion[0];
total_turnaround = turnaround[0];
for (int i=1; i<n; i++){
  wait[i] = completion[i-1];
  completion[i] = wait[i] + burst[i];
  turnaround[i] = completion[i];
  total_wait += wait[i];
  total_turnaround += turnaround[i];
}

printf("\n Process \t Burst Time \t Priority
      \t Turnaround Time \t Waiting Time \n");

for(i=0; i<n; i++){
  printf("%d \t %d \t %d \t %d \t %d \t %d ",
    process[i], burst[i], priority[i], wait[i],
    turnaround[i]);
}

printf("\n Average Waiting Time: %f2f ",
      (float) total_wait/n);
printf("\n Average Turnaround Time: %.2f\n",
    (float) total_turnaround/n);
    return 0;
}
```

Priority Scheduling Non-Preemptive

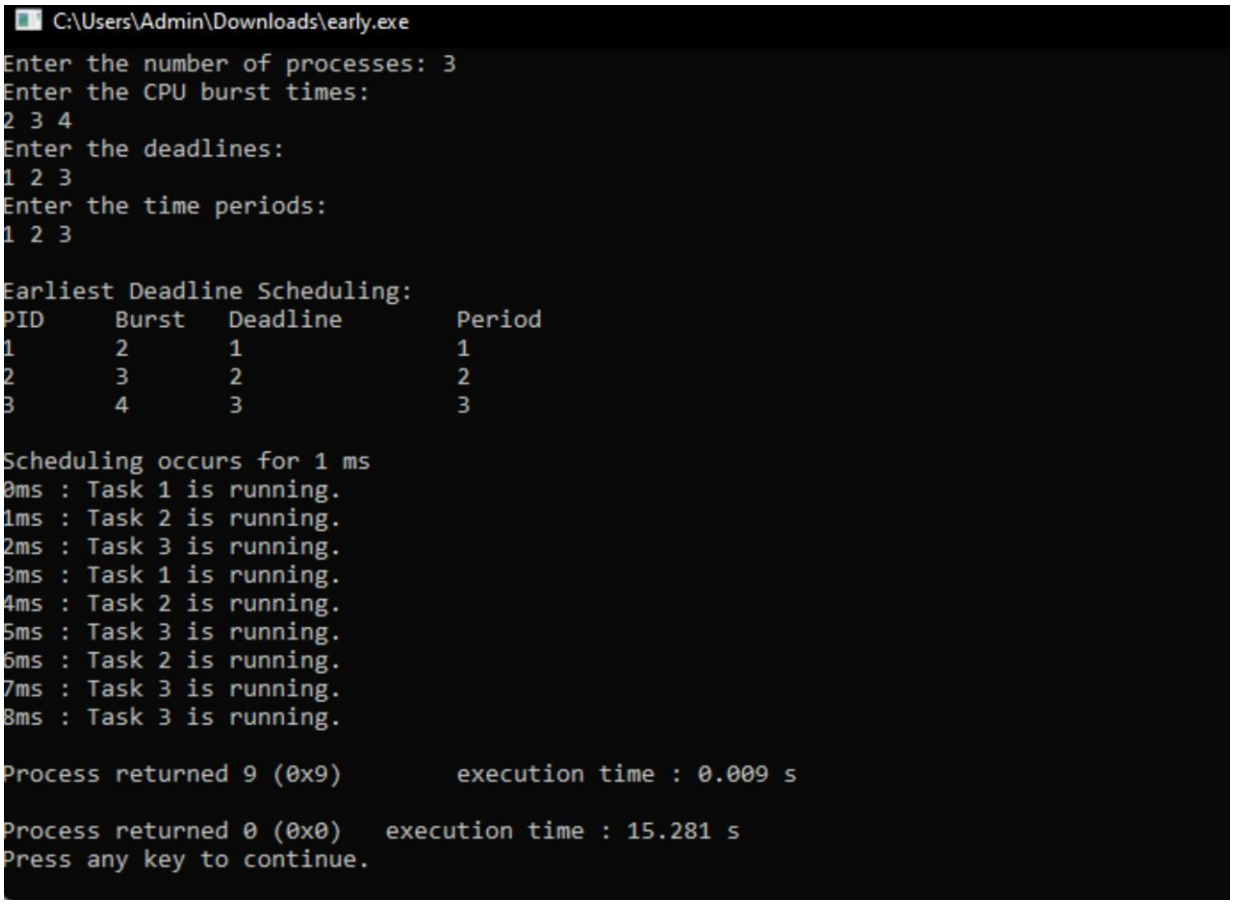
```
#include <stdio.h>
int main ( ) {
    int n, i, j ;
    int burst [20], priority [20], process [20];
    int wait [20], int turnaround [20], time
      completion [20];
    int total_wait=0, total_turnaround=0;
    printf ("Enter the number of processes: ");
    scanf ("%d", &n);
    printf (" Enter burst time and priority for
      each process: \n");
    for (i=0; i<n; i++){
    printf (" Process %d: ", i+1);
    Scanf ("%d %d", &burst [i], &priority [i]);
    process [i] = i+1;
}
for (i=0; i<n; i++)
{
    for (j=i+1; j<n; j++) {
        if (priority [i] > priority [j]) {
            int temp = priority [i];
            priority [i] = priority [j];
            priority [j] = temp;
            temp = burst [i];
            burst process [i] = burst [j].
            process [j] = temp
```

EARILIEST DEADLINE CODE:

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

typedef struct {     int
pid;     int burst_time;
int deadline;     int
period;     int
remaining_time;
} Process;

// Function to compare processes based on their deadlines int
compare_deadlines(const void *a, const void *b) {     return
((Process *)a)->deadline - ((Process *)b)->deadline;
}

int main() {     int
num_processes;

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

   Process processes[num_processes];

   printf("Enter the CPU burst times:\n");
for (int i = 0; i < num_processes; i++) {
scanf("%d", &processes[i].burst_time);
processes[i].pid = i + 1;
      processes[i].remaining_time = processes[i].burst_time;
   }
```

```
    printf("Enter the deadlines:\n");     for
(int i = 0; i < num_processes; i++) {
scanf("%d", &processes[i].deadline);
    }

    printf("Enter the time periods:\n");
for (int i = 0; i < num_processes; i++) {
scanf("%d", &processes[i].period);
    }

    // Sort processes based on deadlines
    qsort(processes, num_processes, sizeof(Process), compare_deadlines);

    printf("\nEarliest Deadline Scheduling:\n");
printf("PID\tBurst\tDeadline\tPeriod\n");     for
(int i = 0; i < num_processes; i++) {
       printf("%d\t%d\t%d\t\t%d\n", processes[i].pid, processes[i].burst_time, processes[i].deadline,
processes[i].period);
    }

    int current_time = 0;     int
completed_processes = 0;

    printf("\nScheduling occurs for %d ms\n", processes[0].deadline); // Assuming the first process
has the earliest deadline

    while (completed_processes < num_processes) {
for (int i = 0; i < num_processes; i++) {            if
(processes[i].remaining_time > 0) {
            printf("%dms : Task %d is running.\n", current_time, processes[i].pid);
processes[i].remaining_time--;
            current_time++;
```

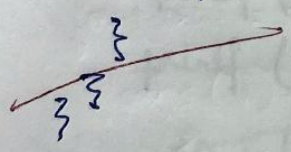
```
            if (processes[i].remaining_time == 0) {
completed_processes++;
            }
        }
    }
}

    printf("\nProcess returned %d (0x%X)\texecution time : %.3f s\n", current_time, current_time,
(float)current_time / 1000.0);

    return 0;
}
```



Earliest Deadline First

```
#include <stdio.h>
typedef struct {
  int pid, BT, RT, period;
} process;
int compare deadline(const void *a, const void *b) {
  return ((process *)a)->deadline - ((process *)b)->
    deadline;
}
int main() {
int main() {
  int num_processes;
  pf ("Enter no of processes: ");
  process Process [num_process];
  pf ("Enter CPU PT on");
  for i=0; i<num_processes(i).BT);
  Proces (i).pid = i+1;
  processes(i).RT = proces(i).BT =
}
pf (" Enter deadline:");
for(i=0; i<num_processes ;i++) {
  scanf ("%d", &Processes (i).deadline);
}
pf (" Enter Time :");
for (int i=0; i<num ;i++) {
  scanf ("%d", &process (i).period);
```

```
qsort (processes, num_processes, sizeof(process));
pf("\n & Enter.%d");
   processes(i).pid, proces(i).BT;
   proces(i).deadline, process(i).period);

}
int CT=0;
int completed_process = 0;
   pf("\n scheduling occurs for %d ms\n");
   processes(0).deadline);
while (completed_processes < num_process){
for (int i=0; i<num; process i++)
  {if (process(i).RT){
   printf("%d ms\n > task :%d");
   current_Time, process(i).pid);
   current_Time++;
   if (processes(i).RT = 0){
      completed_process++;
```



Output :

Enter no of process : 3

2	3	4
1	2	3

System : 6 ms

PID	Burst	Deadline	Period
1	2	1	1
2	3	2	3
3	4	3	3

Scheduling occurs for 6 ms :

0ms : Task1 is running

1ms : Task1 is running

2ms : Task2 is running

3ms : Task2 is running

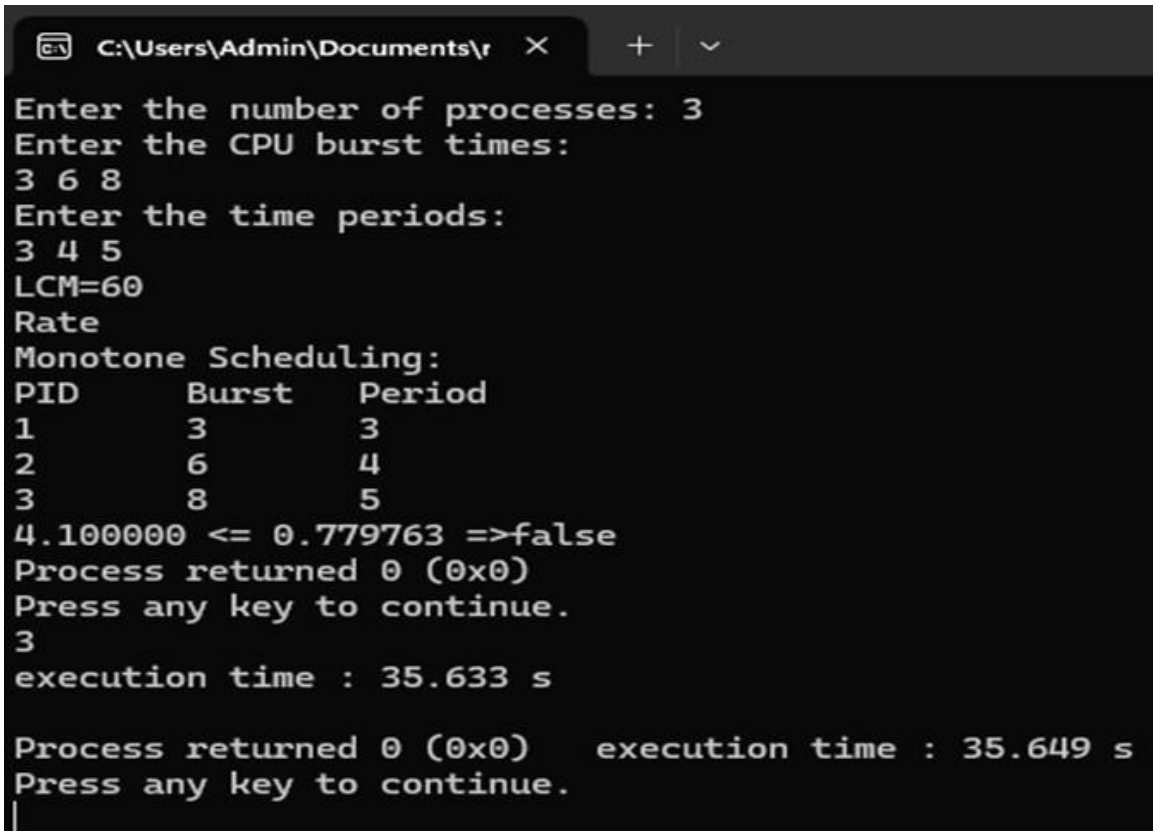
4ms : Task2 is running

5ms : Task3 is running

RATE-MONOTONIC

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

typedef struct {     int
id, burst, period;
} Task;

int gcd(int a, int b) {     return (b ==
0) ? a : gcd(b, a % b);
}

int lcm(int a, int b) {
return (a * b) / gcd(a, b);
}

int findLCM(Task tasks[], int n) {     int
result = tasks[0].period;     for (int i = 1;
i < n; i++)         result = lcm(result,
tasks[i].period);     return result;
}

void rateMonotonic(Task tasks[], int n) {
float utilization = 0;
   printf("\nRate Monotonic Scheduling:\nPID\tBurst\tPeriod\n");
for (int i = 0; i < n; i++) {
       printf("%d\t%d\t%d\n", tasks[i].id, tasks[i].burst, tasks[i].period);
utilization += (float)tasks[i].burst / tasks[i].period;
   }

   float bound = n * (pow(2, (1.0 / n)) - 1);
```

```
   printf("\nUtilization: %.6f, Bound: %.6f\n", utilization, bound);
if (utilization <= bound)         printf("Tasks are Schedulable\n");
else
       printf("Tasks are NOT Schedulable\n");
}

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

   Task tasks[n];
   printf("Enter the CPU burst times: ");
for (int i = 0; i < n; i++)
scanf("%d", &tasks[i].burst);

   printf("Enter the time periods: ");
for (int i = 0; i < n; i++) {
scanf("%d", &tasks[i].period);
tasks[i].id = i + 1;
   }

   rateMonotonic(tasks, n);
return 0;
}
```


C:\Users\Admin\Documents\r
Enter the number of processes: 3
Enter the CPU burst times:
3 6 8
Enter the time periods:
3 4 5
LCM=60
Rate
Monotone Scheduling:
PID Burst Period
1 3 3
2 6 4
3 8 5
4.100000 <= 0.779763 =>false
Process returned 0 (0x0)
Press any key to continue.
3
execution time : 35.633 s
Process returned 0 (0x0) execution time : 35.649 s
Press any key to continue.

Rate Monotonic (scheduling)

```
#include <stdio.h>
#define MAX_Process 10

typedef struct {
    int id;
    int BT;
} Task;

int gcd (int a, int b) {
    return (b == 0) ? a : gcd (b, a % b);
}

int lcm (int a, int b) {
    return (a*b) / gcd (a, b);
}

int find (Task Task[], int n) {
    int result = task (0). period;
    for (int i = 1; i < n; i++)
        result = lcm (result, task (i). period);
    return result;
}

int find LCM (Task tasks [], int n) {
    int result = tasks (0). period;
    for (int i = 1; i < n; i++)
        result = Lcm (result, task P(i)}
}

void rate Monotonic (task tasks [], int n) {
    float utilisation = 0;
    Pf ("In Rate Montonic Scheduling : \n");
    Burst period \n ");
    post int i = 0; i < n; i++)
        Pf ("%d", task (i))
```

```
task p(i).bt , tasks(p(i).period;
utilization = (float) tasks(i).bt. period;
}
float bound = n * (pow(2,1/n) - 1);
  pf("\n utilization : %.d");
    utilization <= bound
  pf("Tasks are scheduled \n");
  else
  pf("Task . period");
}
pf("Tasks.period");
}
int main (){
 int n ;
 pf("Enter the no of proces");
 sf("%.d", &n);
 Task tasks(n);
 pf("Enter the CPU Burst time");
 for(int i=0; i<n ;i++){
  tasks(i).id = i+1;
 }
  rate monotonic (task, n);
  return 0;
}
```

```
printf("!!! Deadline miss for p%d at
        time %d\n", p[current process].pid,
                                time+1);
    }
    else {
        printf("%d\t IDLE\n", time);
    }
}
```

output.

Enter the number of Processes : 3
Enter the CPU burst time;
3 6 8
Enter the Time periods:
3 4 5
LCM = 60

Rate Monotone Scheduling :

PID	Burst	Period
1	3	3
2	6	4
3	8	5

U: 100000 % <= 0.779763 => false.

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PRODUCER CONSUMER CODE:

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

int mutex = 1, full = 0, empty, x = 0;
int *buffer, buffer_size; int in = 0,
out = 0;

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

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

void producer(int id) {     if ((mutex ==
1) && (empty != 0)) {         mutex =
wait(mutex);         full = signal(full);
empty = wait(empty);         int item =
rand() % 50;         buffer[in] = item;
x++;
       printf("Producer %d produced %d\n", id, item);
printf("Buffer:%d\n", item);         in = (in + 1) %
buffer_size;         mutex = signal(mutex);
   } else {
       printf("Buffer is full\n");
   }
}
```

```
void consumer(int id) {     if
((mutex == 1) && (full != 0)) {
mutex = wait(mutex);        full =
wait(full);        empty =
signal(empty);        int item =
buffer[out];
       printf("Consumer %d consumed %d\n", id, item);
x--;
       printf("Current buffer len: %d\n", x);
out = (out + 1) % buffer_size;        mutex
= signal(mutex);
   } else {
       printf("Buffer is empty\n");
   }
}

int main() {     int producers, consumers;
printf("Enter the number of Producers:");
scanf("%d", &producers);     printf("Enter
the number of Consumers:");     scanf("%d",
&consumers);     printf("Enter buffer
capacity:");     scanf("%d", &buffer_size);

   buffer = (int *)malloc(sizeof(int) * buffer_size);
empty = buffer_size;

   for (int i = 1; i <= producers; i++)
printf("Successfully created producer %d\n", i);     for
(int i = 1; i <= consumers; i++)
printf("Successfully created consumer %d\n", i);

   srand(time(NULL));
```

```
   int iterations = 10;     for (int i =
0; i < iterations; i++) {
producer(1);         sleep(1);
consumer(2);         sleep(1);
   }

   free(buffer);
return 0;
}
```

```
Buffer:47
Consumer 2 consumed 47
Current buffer len: 0
Producer 1 produced 9
Buffer:9
Consumer 2 consumed 9
Current buffer len: 0
Producer 1 produced 44
Buffer:44
Consumer 2 consumed 44
Current buffer len: 0
Producer 1 produced 30
Buffer:30
Consumer 2 consumed 30
Current buffer len: 0
Producer 1 produced 1
Buffer:1
Consumer 2 consumed 1
Current buffer len: 0
Producer 1 produced 14
Buffer:14
Consumer 2 consumed 14
Current buffer len: 0
Producer 1 produced 48
Buffer:48
Consumer 2 consumed 48
Current buffer len: 0
Producer 1 produced 2
Buffer:2
Consumer 2 consumed 2
Current buffer len: 0
Producer 1 produced 31
Buffer:31
Consumer 2 consumed 31
Current buffer len: 0
```

Producer Consumer

```
#includ <stdio.h>
#include <stdlib.h>
int mutex = 1, full = 0, empty = x = 0;
int *buffer, buffer_size;
int in = 0, out = 0;
int wait (int s) {
    return (s);
}
int signal (int s) {
    return ++s;
}
Void produce (int id) {
    if (mutex == 1) && (Empty != 0) {
        mutex = wait (mutex);
        full = wait (empty);
        int item = void ( ) % 50;
        buffer (in) = item;
        x++;
        printf ("produce %d produced in %d");
        printf ("Buffer : %d \n", item);
        in = (in++) % buffer_size;
        mutex = signal (mutex);
    } else {
        pf ("Buffer is full \n");
    }
}
void consume (int in) {
    if (mutex == 1 && full != 0) {
```

```
mutex = wait (mutex);
full = wait (full);
empty = signal (empty);
int item = buffer (out);
printf ("consumes %d Consumed %d");
    x--;
}
int main(){
int producer - consumer;
pf ("Enter the no of producer");
    sf ("%d", &produce);
pf ("Enter the buffer capacity");
    sf ("%d, & buffer");
buffer = (int*) malloc (buffer - size);
}
```

Output :-

1. produces
2. consumes
3. Exit

Enter your choice 1

Produces produces item 2

Enter your choice : 1

Buffer is full

Enter your choice : 2

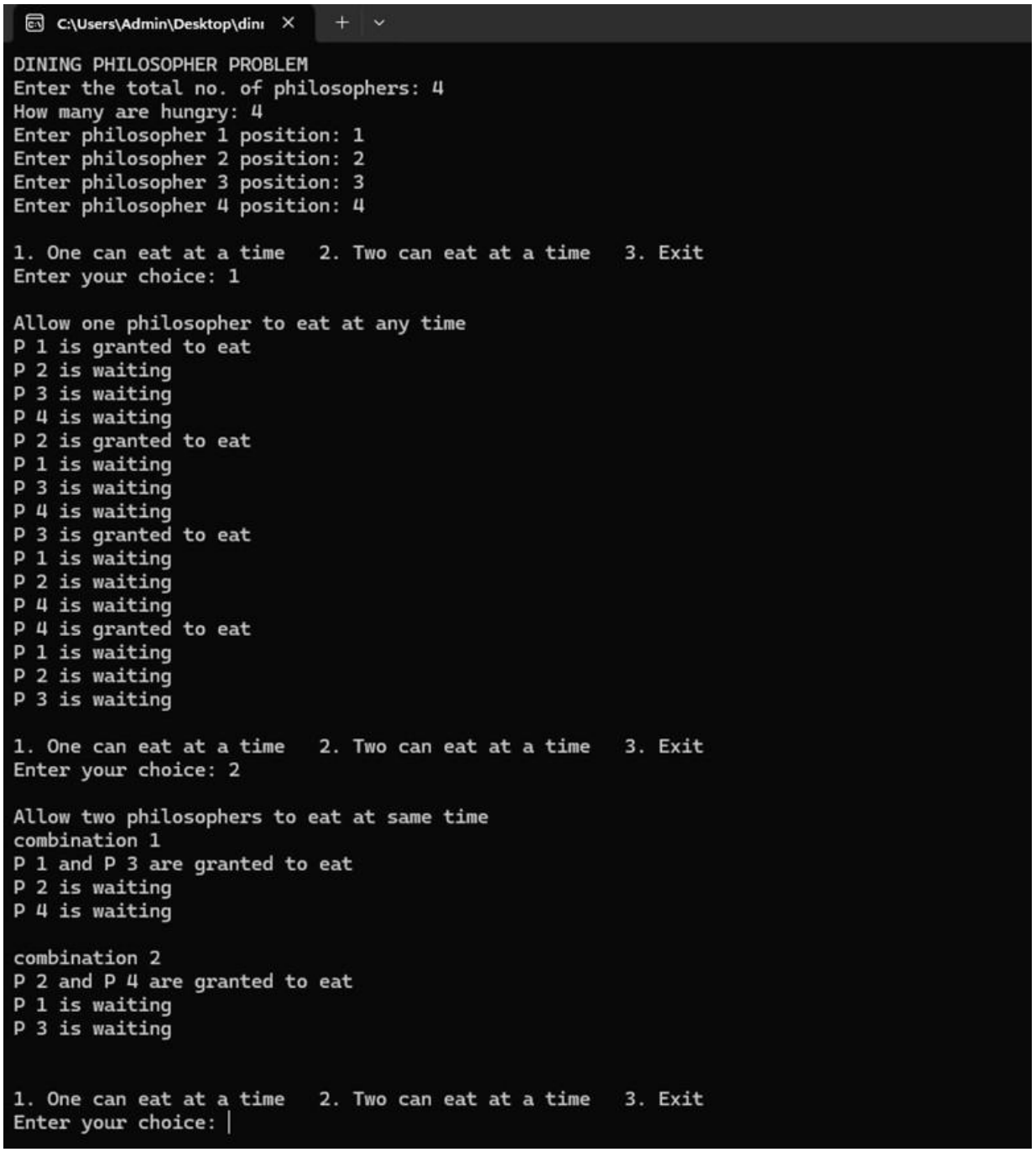
consumes consum item 30

DINNING PHILOSOPHER CODE:

```
#include <pthread.h>
#include <semaphore.h>
#include <stdio.h>
#include <unistd.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[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]);
   }
```

```
}

void take_fork(int phnum)
{
   sem_wait(&mutex);

   state[phnum] = HUNGRY;
   printf("Philosopher %d is Hungry\n", phnum + 1);

   test(phnum);

   sem_post(&mutex);
sem_wait(&S[phnum]);

   sleep(1);
}

void put_fork(int phnum)
{
   sem_wait(&mutex);

   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)
{
```

```
    int* i = (int*) num;

    while (1) {
sleep(1);
take_fork(*i);
sleep(1);
put_fork(*i);
    }
}

int main()
{
    int i;
    pthread_t thread_id[N];

    sem_init(&mutex, 0, 1);
for (i = 0; i < N; i++)
sem_init(&S[i], 0, 0);

    for (i = 0; i < N; i++) {
        pthread_create(&thread_id[i], NULL, philosopher, &phil[i]);
printf("Philosopher %d is thinking\n", i + 1);
    }

    for (i = 0; i < N; i++)
pthread_join(thread_id[i], NULL);

    return 0;
}
```


C:\Users\Admin\Desktop\din
DINING PHILOSOPHER PROBLEM
Enter the total no. of philosophers: 4
How many are hungry: 4
Enter philosopher 1 position: 1
Enter philosopher 2 position: 2
Enter philosopher 3 position: 3
Enter philosopher 4 position: 4
1. One can eat at a time 2. Two can eat at a time 3. Exit
Enter your choice: 1
Allow one philosopher to eat at any time
P 1 is granted to eat
P 2 is waiting
P 3 is waiting
P 4 is waiting
P 2 is granted to eat
P 1 is waiting
P 3 is waiting
P 4 is waiting
P 3 is granted to eat
P 1 is waiting
P 2 is waiting
P 4 is waiting
P 4 is granted to eat
P 1 is waiting
P 2 is waiting
P 3 is waiting
1. One can eat at a time 2. Two can eat at a time 3. Exit
Enter your choice: 2
Allow two philosophers to eat at same time
combination 1
P 1 and P 3 are granted to eat
P 2 is waiting
P 4 is waiting
combination 2
P 2 and P 4 are granted to eat
P 1 is waiting
P 3 is waiting
1. One can eat at a time 2. Two can eat at a time 3. Exit
Enter your choice:

Dining Philosophers

```
#include <stdio.h>
#include <stdlib.h>
int Total philosophers;
int hungry (MAX);
return (abs (a-b) == 1 || abs (a-b) ==
        total philosophers -1);
}
void option1 (int count){
printf ("\n Allows one philosophe to eat
        at any time ");
for (int i=0; i<count ; i++){
printf ("%d is granted to eat\n ");
  hungry (i);
  for (int j = 0; j <count ; j++){
   if (j != i){
  printf ("%d is waiting");
  hungry (j));
  }
}
void option 2 (int count){
printf ("\n Allows two philosopher to eat at
        some time");
int combination = 1;
for (int i = 0; i<count; i++){
    for (int j=0; j<count; j++){
  if (! are Neighbours (hungry(i), hungry(
```

```
{
    printf ("combination %d");
    if (K != && K != j) {
    printf ("P%d is waiting \n");
        hungry (K);
    }
}
printf("\n");
}
if (combination == 1){
printf("No combination found where
        two non-negative philosophers
        can eat: \n");
}
int main (){
int hungry count;
printf ("Enter the total no of philosophers");
scanf("%d, &total philosophers");
}
int choice;
do {
pf ("\n One can eat at a time \n");
2. Two can eat at a time \n");
3. Exit \n");
pf ("Enter your choice");
sf ("%d, &choice");
```

```
case 1:
    option 1 (hungry count);
    break;

case 2:
    option 2 (hungry count);
    break;

case 3:
    printf ("Exiting\n");
    break

default:
    printf("Invalid choice\n");
}
while (choice != 3);
return 0;
}
```

Output:

dining Philosophes problem

Enter the total no of philosopher : 5

How many are hungry : 3

Enter philosopher 1 pos : 2

Enter philosopher 2 pos : 4

Enter philosopher 3 pos 5

Allow one philosophi to eat at any tim

P2 is allowed

P4 is allowed

P5 is allowed

P4 is allowed

P2 is allowed

P5 is allowed

P4 is allowed

P2 is allowed

DEADLOCK AVOIDANCE CODE:

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

#define P 5
#define R 3

bool isSafe(int avail[], int max[][R], int allot[][R]) {
int need[P][R];     bool finish[P] = {false};     int
safeSeq[P];     int work[R];

   for (int i = 0; i < P; i++) {         for
(int j = 0; j < R; j++) {             need[i][j]
= max[i][j] - allot[i][j];
      }
   }

   for (int i = 0; i < R; i++) {
work[i] = avail[i];
   }

   int count = 0;
while (count < P) {
bool found = false;

      for (int p = 0; p < P; p++) {
if (!finish[p]) {                bool
canAllocate = true;                for
(int r = 0; r < R; r++) {
if (need[p][r] > work[r]) {
```

```
canAllocate = false;
break;
                }
            }

            if (canAllocate) {
for (int r = 0; r < R; r++) {
work[r] += allot[p][r];
                }
                safeSeq[count++] = p;
finish[p] = true;                   found
= true;                 break;
            }
        }
    }

    if (!found) {
        printf("System is in an unsafe state\n");
return false;
    }
  }

  printf("System is in a safe state\nSafe sequence is: ");
for (int i = 0; i < P; i++) {       printf("P%d ",
safeSeq[i]);
  }
printf("\n");

  return true;
}

int main() {
```

```
    int avail[] = {3, 3, 2};

    int max[][R] = {
        {7, 5, 3},
        {3, 2, 2},
        {9, 0, 2},
        {2, 2, 2},
        {4, 3, 3}
    };

    int allot[][R] = {
        {0, 1, 0},
        {2, 0, 0},
        {3, 0, 2},
        {2, 1, 1},
        {0, 0, 2}
    };

    isSafe(avail, max, allot);

    return 0;
}
```

```
System is in a safe state
Safe sequence is: P1 P3 P0 P2 P4
```

Deadlock Avoidance

```
#include <stdio.h>
#include <stdbool.h>
int main() {
 int n,m;
pf (process & resources : \n");
sf("%d %d", &n ,& m);
 int alloc (n)(m), max (n)(m), avail (m),
    need (n)(m);
printf ("Enter allocation matrix : \n");
for (int i=0; i<n ; i++)
   for( int j=0 ; j<m; j++)
   sf("%d ", & max (i)(j)) ;
printf ("Enter available matrix \n");
 for (int i= 0 ; i <m ; i++)
   sf (" %d", & avail (i));
   need (i)(j) = max (i)(j), alloca (i)(j)
 bool finish (n);
 for (int i=0 ; i<n ; i++)
   finish (i) = false ;
 int  safe seq (n);
      int count = 0 ;
 while (count <n) {
      bool found = false ;
     for (int p=0 ; p<n; p++) {
        if (! finish(p)) {
           bool can alloc = true ;
     for (int j=0 ; j<m ; j++) {
if (need (p)(j) > avail can Alloc = false;
    break;
```

```
    }
    if (canAllocate) {
        for (int k = 0; k < m; k++)
            avail[k] += alloc[p][k];
        safeSeq[count++] = p;
        finish[p] = true;
        found = true;
    }
  }
}
if (!found) {
    printf("System is not in safe state");
    return 1;
}
```

Output.

Enter no. of processes & resources

5 3

Enter allocation matrix

0	1	0
2	0	0
3	0	2
0	0	2

$P_1 \rightarrow P_3 \rightarrow P_4 \rightarrow P_0 \rightarrow P_2$

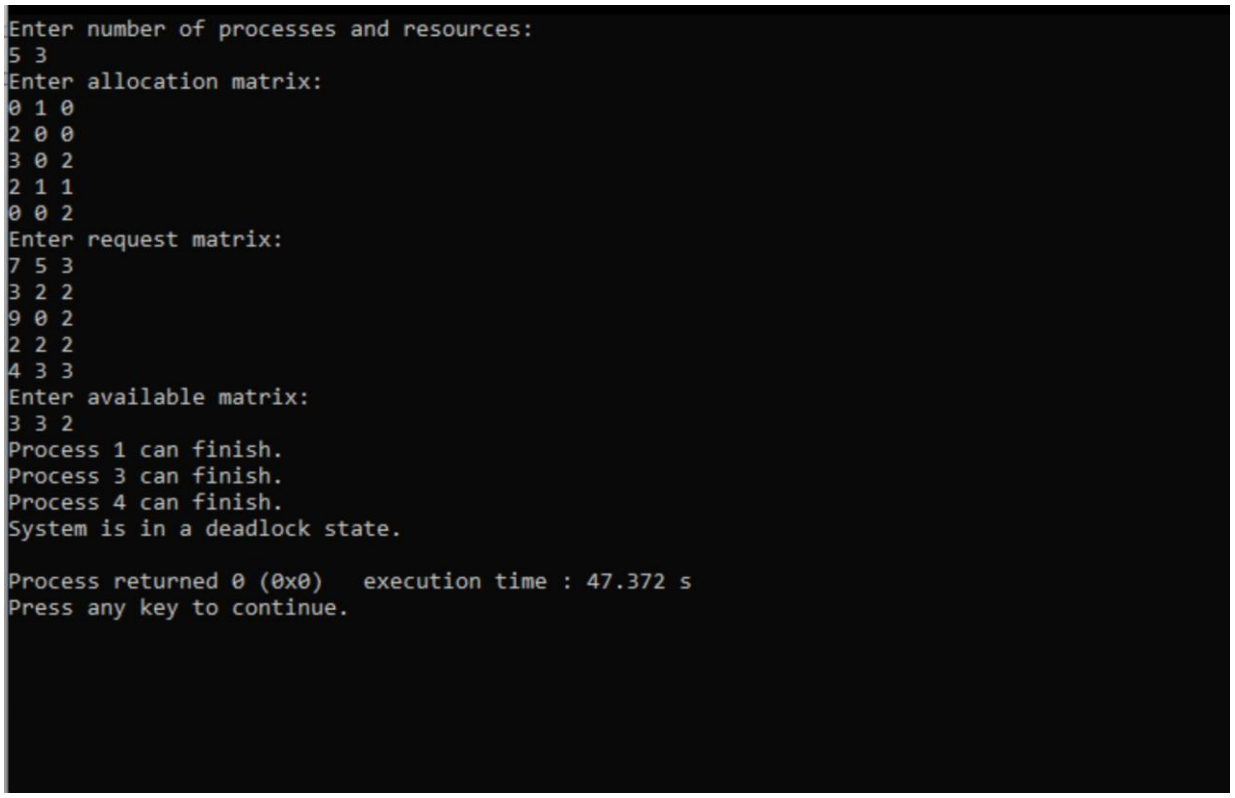
Enter max matrix

7	5	3
3	2	2
9	0	2
2	2	2
4	3	3

DEADLOCK DETECTION CODE:

```
#include <stdio.h>

int main() {
   int n, m, i, j, k;
   printf("Enter number of processes and resources:\n");
scanf("%d %d", &n, &m);

   int alloc[n][m], req[n][m], avail[m], finish[n];

   printf("Enter allocation matrix:\n");
for (i = 0; i < n; i++)        for (j = 0; j
< m; j++)            scanf("%d",
&alloc[i][j]);

   printf("Enter request matrix:\n");
for (i = 0; i < n; i++)        for (j =
0; j < m; j++)            scanf("%d",
&req[i][j]);

   printf("Enter available matrix:\n");
for (i = 0; i < m; i++)
scanf("%d", &avail[i]);

   for (i = 0; i < n; i++)
finish[i] = 0;

   int done;     do {
done = 0;         for (i = 0; i
< n; i++) {             if
(finish[i] == 0) {
```

```
int canFinish = 1;
for (j = 0; j < m; j++) {
if (req[i][j] > avail[j]) {
canFinish = 0;
break;
                }               }
if (canFinish) {                    for (j =
0; j < m; j++)                       avail[j]
+= alloc[i][j];                    finish[i]
= 1;                    done = 1;
                printf("Process %d can finish.\n", i);
              }
           }
        }
   } while (done);

   int deadlock = 0;
for (i = 0; i < n; i++)
if (finish[i] == 0)
deadlock = 1;

   if (deadlock)
      printf("System is in a deadlock state.\n");
else
      printf("System is not in a deadlock state.\n");

   return 0;
}
```


Enter number of processes and resources:
5 3
Enter allocation matrix:
0 1 0
2 0 0
3 0 2
2 1 1
0 0 2
Enter request matrix:
7 5 3
3 2 2
9 0 2
2 2 2
4 3 3
Enter available matrix:
3 3 2
Process 1 can finish.
Process 3 can finish.
Process 4 can finish.
System is in a deadlock state.
Process returned 0 (0x0) execution time : 47.372 s
Press any key to continue.

Deadlock detection

```
#include <stdio.h>
#include<stdbool.h>
#define P 5
#define R 3

void deadlock_detection(int allocation[P][R], int request[P][R], int available[R]){
int work[R];
bool finish[P] = {false};
bool deadlock = false;
for(int i=0; i<R; i++){
work[i] = available[i];
}
int count = 0;
while(count<P){
bool found = false;
for(int i=0; i<P; i++){
if(!finish[i]){
bool canProceed = true;
for(int j=0; j<R; j++){
if(request[i][j] > work[j]){
canProceed = false;
break;
}}
if(canProceed){
for(int j=0; j<R; j++)
work[j] += allocation[i][j];
finish[i] = true;
printf("Process %d is finished\n", i);
found = true;
count++;
}}}
```

```
if (!fin) {
    make;
}
for (int i=0; i<p; j++){
    if (!finish[i]) {
        deadlock = true;
        Pf("No deadlock detected. All process a
          cophetal");
    else {
        printf ("Deadlock detected\n");
int main (){
int allocation [p][r] = {
        {0, 1, 0}, {2, 0, 0}, {3, 0, 2}
        {2, 1, 1}, {0, 0, 2}};
int request [p][r] = {
        {0, 0, 0},
            {2, 0, 2},
            {0, 0, 0},
                {1, 0, 0},
                    {0, 0, 2}};
int available [r] = {0, 0, 0};
deadlock detection (allocation, request,
        available);
        return 0;
```

Output

process P0 is finished. No deadlock
process P1 is finished. detected,
process P3 is finished. All process
process P4 is finished
process P1 is finished

MULTILEVEL QUIENING CODE:

```
#include <stdio.h>

#define MAX_PROCESSES 10
#define TIME_QUANTUM 2

typedef struct {
   int burst_time, arrival_time, queue_type, waiting_time, turnaround_time, response_time,
remaining_time;
} Process;

void round_robin(Process processes[], int n, int time_quantum, int *time) {
int done, i;     do {         done = 1;
       for (i = 0; i < n; i++) {
          if (processes[i].remaining_time > 0) {
done = 0;
             if (processes[i].remaining_time > time_quantum) {
                *time += time_quantum;
                processes[i].remaining_time -= time_quantum;
             } else {
                *time += processes[i].remaining_time;
                processes[i].waiting_time = *time - processes[i].arrival_time - processes[i].burst_time;
processes[i].turnaround_time = *time - processes[i].arrival_time;
processes[i].response_time = processes[i].waiting_time;                processes[i].remaining_time =
0;
             }
          }
       }
   } while (!done);
}

void fcfs(Process processes[], int n, int *time) {
for (int i = 0; i < n; i++) {
```

```
        if (*time < processes[i].arrival_time) {
            *time = processes[i].arrival_time;
        }
        processes[i].waiting_time = *time - processes[i].arrival_time;
        processes[i].turnaround_time = processes[i].waiting_time + processes[i].burst_time;
processes[i].response_time = processes[i].waiting_time;
        *time += processes[i].burst_time;
    }
}

int main() {
    Process processes[MAX_PROCESSES], system_queue[MAX_PROCESSES],
user_queue[MAX_PROCESSES];
    int n, sys_count = 0, user_count = 0, time = 0;
    float avg_waiting = 0, avg_turnaround = 0, avg_response = 0, throughput;

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

    for (int i = 0; i < n; i++) {
        printf("Enter Burst Time, Arrival Time and Queue of P%d: ", i + 1);
scanf("%d %d %d", &processes[i].burst_time, &processes[i].arrival_time,
&processes[i].queue_type);
        processes[i].remaining_time = processes[i].burst_time;

        if (processes[i].queue_type == 1) {
system_queue[sys_count++] = processes[i];
        } else {
            user_queue[user_count++] = processes[i];
        }
    }
```

```
   // Sort user processes by arrival time for FCFS
for (int i = 0; i < user_count - 1; i++) {         for
(int j = 0; j < user_count - i - 1; j++) {
          if (user_queue[j].arrival_time > user_queue[j + 1].arrival_time) {
Process temp = user_queue[j];                 user_queue[j] = user_queue[j +
1];                 user_queue[j + 1] = temp;
          }
       }
   }

   printf("\nQueue 1 is System Process\nQueue 2 is User Process\n");
round_robin(system_queue, sys_count, TIME_QUANTUM, &time);     fcfs(user_queue,
user_count, &time);

   printf("\nProcess  Waiting Time  Turn Around Time  Response Time\n");

   for (int i = 0; i < sys_count; i++) {
      avg_waiting += system_queue[i].waiting_time;
avg_turnaround += system_queue[i].turnaround_time;
avg_response += system_queue[i].response_time;
      printf("%d        %d          %d              %d\n", i + 1, system_queue[i].waiting_time,
system_queue[i].turnaround_time, system_queue[i].response_time);
   }

   for (int i = 0; i < user_count; i++) {         avg_waiting
+= user_queue[i].waiting_time;         avg_turnaround +=
user_queue[i].turnaround_time;         avg_response +=
user_queue[i].response_time;
      printf("%d        %d          %d              %d\n", i + 1 + sys_count, user_queue[i].waiting_time,
user_queue[i].turnaround_time, user_queue[i].response_time);
   }
```

```
    avg_waiting /= n;
avg_turnaround /= n;
avg_response /= n;     throughput
= (float)n / time;

    printf("\nAverage Waiting Time: %.2f", avg_waiting);
printf("\nAverage Turn Around Time: %.2f", avg_turnaround);
printf("\nAverage Response Time: %.2f", avg_response);
printf("\nThroughput: %.2f", throughput);
    printf("\nProcess returned %d (0x%d) execution time: %.3f s\n", time, time, (float)time);

    return 0;
}
```

```
Enter number of processes: 4
Enter Burst Time, Arrival Time and Queue of P1: 2
0
1
Enter Burst Time, Arrival Time and Queue of P2: 1
0
2
Enter Burst Time, Arrival Time and Queue of P3: 5
0

1
Enter Burst Time, Arrival Time and Queue of P4: 3
0

2

Queue 1 is System Process
Queue 2 is User Process

Process Waiting Time    Turn Around Time        Response Time
1       0               2                       0
2       2               3                       2
3       3               8                       3
4       8               11                      8

Average Waiting Time: 3.25
Average Turn Around Time: 6.00
Average Response Time: 3.25
Throughput: 0.36
```

ROUND ROBIN CODE:

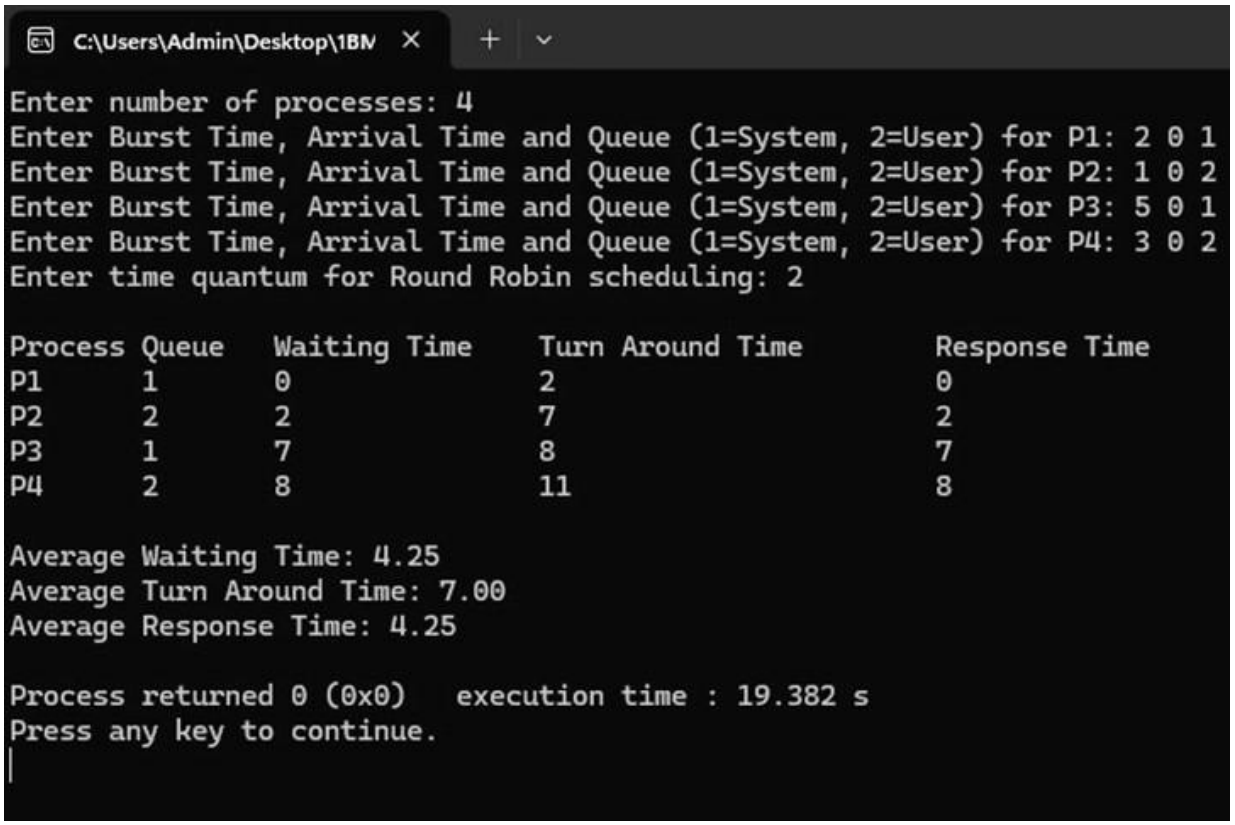
```
#include <stdio.h>

#define MAX_PROCESSES 10

typedef struct {     int pid;     int bt;

int at;     int queue; } Process; void

sortByArrival(Process p[], int n) {

Process temp;     for (int i = 0; i < n - 1;

i++) {             for (int j = 0; j < n - i -

1; j++) {          if (p[j].at > p[j + 1].at) {

temp = p[j];                p[j] = p[j + 1];

p[j + 1] = temp;

          }

     }

   }

} void roundRobin(Process p[], int n, int quantum, int wt[], int tat[], int rt[])

{     int remaining_bt[MAX_PROCESSES];

   for (int i = 0; i < n; i++)      remaining_bt[i] =

p[i].bt;     int t = 0, completed = 0;     while

(completed < n) {        int executed = 0;

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

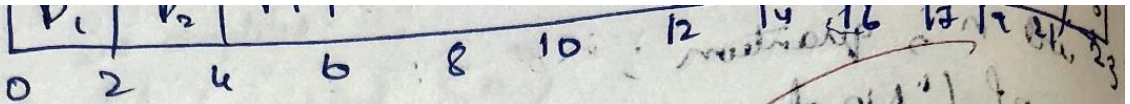
```
(remaining_bt[i] > 0) {                    if (rt[i]
== -1) rt[i] = t;                    if
(remaining_bt[i] > quantum) {                    t
+= quantum;                    remaining_bt[i] -
= quantum;
                    } else {
t += remaining_bt[i];
tat[i] = t - p[i].at;                    wt[i]
= tat[i] - p[i].bt;

                    remaining_bt[i] = 0;
                    completed++;

            }

                    executed = 1;
            }

            }

            if (!executed) t++;

    }

} void fcfs(Process p[], int n, int start_time, int wt[], int tat[], int rt[])

{     int time = start_time;     for (int i = 0; i < n; i++) {          if (time
```

```
< p[i].at) time = p[i].at;          rt[i] = time - p[i].at;              wt[i] =
rt[i];              tat[i] = wt[i] + p[i].bt;          time += p[i].bt;
   }
}
int main() {     int
n, quantum;
   Process p[MAX_PROCESSES], sys[MAX_PROCESSES], usr[MAX_PROCESSES];
   int sys_count = 0, usr_count = 0;
   int wt[MAX_PROCESSES], tat[MAX_PROCESSES], rt[MAX_PROCESSES];
   printf("Enter number of processes: ");
scanf("%d", &n); for (int i = 0; i < n;
i++) {
        printf("Enter Burst Time, Arrival Time and Queue (1=System, 2=User) for P%d: ", i +
1);       p[i].pid = i + 1;          scanf("%d %d %d", &p[i].bt,
&p[i].at, &p[i].queue);          if (p[i].queue == 1)
sys[sys_count++] = p[i];        else
        usr[usr_count++] =
p[i];              wt[i] = 0;
tat[i] = 0;        rt[i] = -1;
   }
```

```
   printf("Enter time quantum for Round Robin scheduling: ");     scanf("%d",
&quantum);     sortByArrival(sys, sys_count);     sortByArrival(usr, usr_count);
roundRobin(sys, sys_count, quantum, wt, tat, rt);     int last_sys_time = (sys_count > 0)
? tat[sys_count - 1] + sys[sys_count - 1].at : 0;     fcfs(usr, usr_count, last_sys_time,
&wt[sys_count], &tat[sys_count], &rt[sys_count]);     printf("\nProcess\tQueue\tWaiting
Time\tTurn Around Time\tResponse Time\n");
   for (int i = 0; i < n; i++)         printf("P%d\t%d\t%d\t\t%d\t\t\t%d\n", p[i].pid,
p[i].queue, wt[i], tat[i], rt[i]);  float avg_wt = 0, avg_tat = 0, avg_rt = 0; for (int i
= 0; i < n; i++) {
           avg_wt += wt[i];
avg_tat += tat[i];         avg_rt
+= rt[i];
   }
   printf("\nAverage Waiting Time: %.2f", avg_wt / n);
printf("\nAverage Turn Around Time: %.2f", avg_tat / n);
printf("\nAverage Response Time: %.2f\n", avg_rt / n);     return 0;

}
```

Output:


C:\Users\Admin\Desktop\1BM
Enter number of processes: 4
Enter Burst Time, Arrival Time and Queue (1=System, 2=User) for P1: 2 0 1
Enter Burst Time, Arrival Time and Queue (1=System, 2=User) for P2: 1 0 2
Enter Burst Time, Arrival Time and Queue (1=System, 2=User) for P3: 5 0 1
Enter Burst Time, Arrival Time and Queue (1=System, 2=User) for P4: 3 0 2
Enter time quantum for Round Robin scheduling: 2
Process Queue Waiting Time Turn Around Time Response Time
P1 1 0 2 0
P2 2 2 7 2
P3 1 7 8 7
P4 2 8 11 8
Average Waiting Time: 4.25
Average Turn Around Time: 7.00
Average Response Time: 4.25
Process returned 0 (0x0) execution time : 19.382 s
Press any key to continue.



LAB.3

1. C program to stimulate multilevel queue

```
#include <stdio.h>
typedef struct {
    int pid;
    int bt;
}
void arrival (process p(), int n) {
    process temp;
    for (i=0; i<n; i++) {
    for(j=0; j<n; j-1; j++)
        temp = p(j);
        p(j) = p(j+1);
        p(j+1) = temp;
}
}
```

```
void roundRobin (process(), int n, int quantum)
{
int remain_bt (max . process);
remainingbt(i) = p(i).bt;
int t=0; completed=0;
while (comp < n) {
int executed = 0;
for (int i=1 ; i<n ; i++) {
if (remaining_bt(i) >0) {
if (remaining_bt(i) > quantum) {
t += quantum;
remaining_bt[] -= quantum;
} else {
t += remaining_bt(i) ;
tat(i) = t - p(i).at;
wt(i) = tat(i) - p(i).at;
completed i++ ;
executed = 1;
}
if (! executed)
}
```

O/p

```
output
Enter the number of process : 4
Enter ft AT and quan (1=syst, 2=usr)
for P1 : 2 0 2
Enter ft BT and quan (1=syst, 2=usr) for P2
Enter ft, AT and quan (1=syst, 2=usr) for P3
```

P	Q	WT	TAT	RT
P1	1	0	1	0
P2	2	1	6	1
P3	1	6	8	6

Avg: 3.75 Avg: 6.75 Avg: 3.75

```
void fcfs (proces P(), int n, int start,
int wt(), int tat())
{ int st(C);
for (i=0; i<n; i++) {
if (time < P(i).at ) > time = P(i).at
time t = P(i).bt ;
```

MEMORY MANAGEMENT UNIT (BEST FIT,WORST FIRST,FIRST FIT) CODE:

```
#include <stdio.h>

#define MAX_BLOCKS 20
#define MAX_PROCESSES 10

void worstFit(int blockSize[], int m, int processSize[], int n) {
int allocation[n];     for (int i = 0; i < n; i++) {
allocation[i] = -1;
   }

   for (int i = 0; i < n; i++) {         int
maxIndex = -1;         for (int j = 0; j < m;
j++) {             if (blockSize[j] >=
processSize[i]) {
               if (maxIndex == -1 || blockSize[maxIndex] < blockSize[j]) {
maxIndex = j;
               }
           }
       }
       if (maxIndex != -1) {             allocation[i]
= maxIndex;             blockSize[maxIndex] -=
processSize[i];
       }
   }

   printf("\nWorst Fit Allocation:\n");
for (int i = 0; i < n; i++) {         if
(allocation[i] != -1) {
           printf("Process %d allocated to Block %d\n", i + 1, allocation[i] + 1);
       } else {
           printf("Process %d not allocated\n", i + 1);
```

```
        }
    }
}

void bestFit(int blockSize[], int m, int processSize[], int n) {
int allocation[n];     for (int i = 0; i < n; i++) {
allocation[i] = -1;
    }

    for (int i = 0; i < n; i++) {         int
bestIndex = -1;         for (int j = 0; j < m;
j++) {             if (blockSize[j] >=
processSize[i]) {
                if (bestIndex == -1 || blockSize[bestIndex] > blockSize[j]) {
bestIndex = j;
                }
            }
        }
        if (bestIndex != -1) {             allocation[i]
= bestIndex;             blockSize[bestIndex] -=
processSize[i];
        }
    }

    printf("\nBest Fit Allocation:\n");
for (int i = 0; i < n; i++) {         if
(allocation[i] != -1) {
            printf("Process %d allocated to Block %d\n", i + 1, allocation[i] + 1);
        } else {
            printf("Process %d not allocated\n", i + 1);
        }
    }
```

```
}

void firstFit(int blockSize[], int m, int processSize[], int n) {
int allocation[n];     for (int i = 0; i < n; i++) {
allocation[i] = -1;
   }

   for (int i = 0; i < n; i++) {         for (int j
= 0; j < m; j++) {             if (blockSize[j]
>= processSize[i]) {                 allocation[i]
= j;                 blockSize[j] -=
processSize[i];                 break;
          }
       }
   }

   printf("\nFirst Fit Allocation:\n");
for (int i = 0; i < n; i++) {         if
(allocation[i] != -1) {
          printf("Process %d allocated to Block %d\n", i + 1, allocation[i] + 1);
       } else {
          printf("Process %d not allocated\n", i + 1);
       }
   }
}

int main() {
   int blockSize[MAX_BLOCKS], processSize[MAX_PROCESSES];
int m, n;

   printf("Enter the number of memory blocks: ");
scanf("%d", &m);
```

```
    printf("Enter the size of each memory block:\n");
for (int i = 0; i < m; i++) {         printf("Block %d:
", i + 1);         scanf("%d", &blockSize[i]);
    }

    printf("Enter the number of processes: ");
scanf("%d", &n);
    printf("Enter the size of each process:\n");
for (int i = 0; i < n; i++) {
printf("Process %d: ", i + 1);
scanf("%d", &processSize[i]);
    }

    firstFit(blockSize, m, processSize, n);
bestFit(blockSize, m, processSize, n);
worstFit(blockSize, m, processSize, n);

    return 0;
}
```

```
Block 5: 600
Enter the number of processes: 4
Enter the size of each process:
Process 1: 212
Process 2: 417
Process 3: 112
Process 4: 426

First Fit Allocation:
Process 1 allocated to Block 2
Process 2 allocated to Block 5
Process 3 allocated to Block 2
Process 4 not allocated

Best Fit Allocation:
Process 1 allocated to Block 4
Process 2 not allocated
Process 3 allocated to Block 2
Process 4 not allocated

Worst Fit Allocation:
Process 1 not allocated
Process 2 not allocated
Process 3 allocated to Block 3
Process 4 not allocated
```

Memory Management (Unix Schemi)

best fit / worst fit / optimal

```
#include <stdio.h>
struct Block {
 int block_no;
 int block_size;
 int is_free ; 8 ;
 struct_File {
  int file_no ;
  int file_size ;
};
void bolt (struct_Block bocks (), int n_block,
      struct File file (); int n_files )
{ printf (" \n Memory Management Schemi ");
 printf (" File no\t File Size \t Block no \n ");
 for (int i=0 ; i < n_file ; i++)
 {
  int best_fit_block = -1 ;
  int min_management = 10000 ;
 for (int j=.0 ;j<n ;j++) {
 int nagement ~~< min~~ = blocks [i]_ blocksize - file[i
 if (fragment < min_fragment) {
   min_fragement = fragement ;
        best_fit_block = j ;
 }
 if (best_fit_block ! = -1) {
  blocks (best_fit_block) .is_free = 0 ;
  printf ("%d \t\t %d \t\t \t %d");
   files (i)_file no; file (i)_file size )
```

```
blocks (best_fit_block) - block_no
block (best_fit_block) block_size
    min fragement;
}
else {
  pf ("%d \t\t %d \t\t %d \t\t ");
  files (i) - file no;
  files (i) - file size;
}
}
int main () {
  int n_blocks, n_files;
  pf ("%d", & n_blocks)
  pf ("Enter the no of files");
  sf ("%d" & n_files);
  struct Block blocks (n_blocks);
  struct Block files (n_files);
  for (int i=0; i<n; i++)
  {
    blocks(i) - block_no = (i);
    pf ("Enter the size of block");
    sf ("%d", & block (i), block_size");
    block (i) - is free = 1;
  }
  for (int i=0; i<n_files; i++){
    files (i) file_no = 1;
    pf ("Enter size of file %d");
  }
  for (int i=0; (i<n_blocks; i++)
  {
    block(i) - is - free = 1;
  }
```

Output:-

Enter no of blocks : 5
Enter no of files : 4
Enter size of block : 100
Enter size of block : 200
Enter size of block : 400

Output

memory	Fullsize	Block_no	Block_size
1	212	3	300
2	146	4	200
3	426	2	500
4	404	N/A	N/A

FIFO / LRU / optimal

```
#include <stdio.h>
int search ( int key, int frame( ), int size
{
  for ( int i=0 ; i<size ; i++ ) {
    if (frame (i) == key)
      return 0;
  }
void stimulate FIFO ( int pages ( ), int n,
```

PAGE REPLACEMENT PROGRAM(LRU,OPTIMAL,FIFO)

CODE:

```
#include <stdio.h>
#include <stdbool.h>
#define MAX_FRAMES 10
#define MAX_PAGES 50


bool isPageInFrame(int frames[], int page, int frameCount) {
for (int i = 0; i < frameCount; i++) {        if (frames[i] ==
page) {            return true;
      }    }
return false;
}


int fifo(int pages[], int pageCount, int frameCount) {
int frames[MAX_FRAMES], front = 0, pageFaults = 0;

   for (int i = 0; i < pageCount; i++) {
      if (!isPageInFrame(frames, pages[i], frameCount)) {
frames[front] = pages[i];            front = (front + 1) %
frameCount;            pageFaults++;
      }
   }
   return pageFaults;
}


int lru(int pages[], int pageCount, int frameCount) {
   int frames[MAX_FRAMES], lastUsed[MAX_FRAMES], pageFaults = 0;
```

```
    for (int i = 0; i < pageCount; i++) {
        if (!isPageInFrame(frames, pages[i], frameCount)) {
int leastRecentlyUsedIndex = 0;             for (int j = 1; j <
frameCount; j++) {
                if (lastUsed[j] < lastUsed[leastRecentlyUsedIndex]) {
leastRecentlyUsedIndex = j;
                }
            }
            frames[leastRecentlyUsedIndex] = pages[i];
pageFaults++;
        }
        for (int j = 0; j < frameCount; j++) {
lastUsed[j]++;
        }
        lastUsed[pages[i] % frameCount] = 0;
    }
    return pageFaults;
}


int optimal(int pages[], int pageCount, int frameCount) {
int frames[MAX_FRAMES], pageFaults = 0;

    for (int i = 0; i < pageCount; i++) {
        if (!isPageInFrame(frames, pages[i], frameCount)) {
int farthestIndex = -1, replaceIndex = -1;             for (int j
= 0; j < frameCount; j++) {                 int nextUse =
pageCount;
                for (int k = i + 1; k < pageCount; k++) {
if (frames[j] == pages[k]) {
nextUse = k;                         break;
                    }
```

```
            }
            if (nextUse > farthestIndex) {
farthestIndex = nextUse;                    replaceIndex
= j;
            }
          }
          frames[replaceIndex] = pages[i];
pageFaults++;
       }
   }
   return pageFaults;
}

int main() {
   int pages[MAX_PAGES], pageCount, frameCount;

   printf("Enter number of pages: ");
scanf("%d", &pageCount);
printf("Enter page sequence: ");     for
(int i = 0; i < pageCount; i++) {
scanf("%d", &pages[i]);
   }
   printf("Enter number of frames: ");
scanf("%d", &frameCount);

   printf("FIFO Page Faults: %d\n", fifo(pages, pageCount, frameCount));
printf("LRU Page Faults: %d\n", lru(pages, pageCount, frameCount));
printf("Optimal Page Faults: %d\n", optimal(pages, pageCount, frameCount));

   return 0;
}
```

```
Enter number of pages: 12
Enter page sequence: 1 3 0 3 5 6 3 0 3 5 2 3
Enter number of frames: 3
```

		Block_no	Block_size
1	212	3	300
2	146	4	200
3	426	2	500
4	404	N/A	N/A

FIFO / LRU / optimal

```
#include <stdio.h>
int search ( int key, int frame(), int size
{
    for ( int i=0 ; i<size ; i++ ) {
        if (frame (i) == key)
            return 0; }
void stimulate FIFO ( int pages (), int n,
                      int transaction )
{ int frame ( framesize ); front = 0, faults = 0
  for (int i=0; i < frame (size); i++)
      frame (i) = 1
  for (int i=0 ; i<framesize ; i++)
      frame (i) = 1
{
  frame (front) = pages [i]
```

```
if (!search(pages[i], frames,
                framesize))
{
faults++;
}
else
{
hits++;
}
}
printf("FIFO pages faults : %d Page hits :
  %d\n", faults, hits);
int main(){
int n, frame size;
printf("Enter the size of the pages");
scanf("%d", &n);
int pages(n);
printf("Enter page strings :");
for(int i=0; i<n; i++)
    scanf("%d", &pages[i]);
Pf("Enter the no of page frame :");
    Sf("%d", &frame size[i]);
    return 0;
}
```

Output :-

Enter the size of pages : 7

Enter the pages String : 1 30 35 6 2

FIFO page faults : 6

page hits : 1