



**Department of Computer Science and Engineering**

'Jnana Prabha', Virgo Nagar Post, Bengaluru-560049

**Academic Year: 2023-24**

# **LABORATORY MANUAL**

**SEMESTER : III**

**SUBJECT : Operating Systems**

**SUBCODE : BCS303**

**NAME:** \_\_\_\_\_

**USN:** \_\_\_\_\_

**SECTION:** \_\_\_\_\_

**BATCH:** \_\_\_\_\_

## PROGRAM OUTCOMES

### **Engineering Graduates will able to:**

**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

**Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

**Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

**Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice. Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

**Project management and finance:** Demonstrate knowledge and understanding of the Engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

**Life -long learning:** Recognize the need for and have the preparation and ability to engage in independent and life -long learning in the broadest context of technological change.



## **INSTITUTE VISION AND MISSION**

### **VISION**

The East Point College of Engineering and Technology aspires to be a globally acclaimed institution, recognized for excellence in engineering education, applied research and nurturing students for holistic development.

### **MISSION**

**M1:** To create engineering graduates through quality education and to nurture innovation, creativity and excellence in teaching, learning and research

**M2:** To serve the technical, scientific, economic and societal developmental needs of our communities

**M3:** To induce integrity, teamwork, critical thinking, personality development and ethics in students and to lay the foundation for lifelong learning

## **Department of Computer Science and Engineering**

### **DEPARTMENT VISION AND MISSION**

#### **VISION**

The department aspires to be a Centre of excellence in Computer Science & Engineering to develop competent professionals through holistic development.

#### **MISSION**

**M1:** To create successful Computer Science Engineering graduates through effective pedagogies, the latest tools and technologies, and excellence in teaching and learning.

**M2:** To augment experiential learning skills to serve technical, scientific, economic, and social developmental needs.

**M3:** To instil integrity, critical thinking, personality development, and ethics in students for a successful career in Industries, Research, and Entrepreneurship.

#### **PROGRAM EDUCATIONAL OBJECTIVES (PEOs)**

**PEO 1:** To produce graduates who can perform technical roles to contribute effectively in software industries and R&D Centre.

**PEO 2:** To produce graduates having the ability to adapt and contribute in key domains of computer science and engineering to develop competent solutions.

**PEO 3:** To produce graduates who can provide socially and ethically responsible solutions while adapting to new trends in the domain to carve a successful career in the industry.

## **PROGRAM SPECIFIC OUTCOMES (PSOs)**

**PSO1:** To conceptualize, model, design, simulate, analyze, develop, test, and validate computing systems and solve technical problems arising in the field of computer science & engineering.

**PSO2:** To specialize in the sub-areas of computer science & engineering systems such as cloud computing, Robotic Process Automation, cyber security, big data analytics, user interface design, and IOT to meet industry requirements.

**PSO3:** To build innovative solutions to meet the demands of the industry using appropriate tools and techniques.

## **COURSE LEARNING OBJECTIVES**

- To Demonstrate the need for OS and different types of OS
- To discuss suitable techniques for management of different resources
- To demonstrate different APIs/Commands related to processor, memory and storage and file system management.

## **COURSE OUTCOMES**

**CO1:** Explain the structure and functionality of operating system

**CO2:** Apply appropriate CPU scheduling algorithms for the given problem.

**CO3:** Analyze the various techniques for process synchronization and deadlock handling.

**CO4:** Apply the various techniques for memory management

**CO5:** Explain file and secondary storage management strategies.

**CO6:** Describe the need for information protection mechanisms.

Course Code	<b>BCS303</b>	CIE Marks	50
Teaching Hours/Weeks (L: T: P: S)	3:0:2:0	SEE Marks	50
Total Hours of Pedagogy	40T+20P	Total Marks	100
Credits	04	Exam Hours	3

### Course Outcomes:

- CO 1. Explain the structure and functionality of operating system  
CO 2. Apply appropriate CPU scheduling algorithms for the given problem  
CO 3. Analyze the various techniques for process synchronization and deadlock handling.  
CO 4. Apply the various techniques for memory management  
CO 5. Explain file and secondary storage management strategies.  
CO 6. Describe the need for information protection mechanisms

<b>SL NO</b>	<b>List of Experiments</b>
<b>1</b>	Develop a c program to implement the Process system calls (fork (), exec(), wait(), create process, terminate process)
<b>2</b>	Simulate the following CPU scheduling algorithms to find turnaround time and waiting time a) FCFS b) SJF c) Round Robin d) Priority.
<b>3</b>	Develop a C program to simulate producer-consumer problem using semaphores.
<b>4</b>	Develop a C program which demonstrates interprocess communication between a reader process and a writer process. Use mkfifo, open, read, write and close APIs in your program.
<b>5</b>	Develop a C program to simulate Bankers Algorithm for DeadLock Avoidance.
<b>6</b>	Develop a C program to simulate the following contiguous memory allocation Techniques: a) Worst fit    b) Best fit        c) First fit.
<b>7</b>	Develop a C program to simulate page replacement algorithms: a) FIFO   b) LRU
<b>8</b>	Simulate following File Organization Techniques a) Single level directory        b) Two level directory
<b>9</b>	Develop a C program to simulate the Linked file allocation strategies.
<b>10</b>	Develop a C program to simulate SCAN disk scheduling algorithm.

**Course outcomes (Course Skill Set):**

At the end of the course, the student will be able to:

CO 1. Explain the structure and functionality of operating system

CO 2. Apply appropriate CPU scheduling algorithms for the given problem.

CO 3. Analyse the various techniques for process synchronization and deadlock handling.

CO 4. Apply the various techniques for memory management

CO 5. Explain file and secondary storage management strategies.

CO 6. Describe the need for information protection mechanisms

**CIE for the practical component of the IPCC**

- **15 marks** for the conduction of the experiment and preparation of laboratory record, and **10 marks** for the test to be conducted after the completion of all the laboratory sessions.
- On completion of every experiment/program in the laboratory, the students shall be evaluated including viva-voce and marks shall be awarded on the same day.
- The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report. Each experiment report can be evaluated for 10 marks. Marks of all experiments' write-ups are added and scaled down to **15 marks**.
- The laboratory test (**duration 02/03 hours**) after completion of all the experiments shall be conducted for 50 marks and scaled down to **10 marks**.
- Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for **25 marks**.
- The student has to secure 40% of 25 marks to qualify in the CIE of the practical component of the IPCC.

**SEE for IPCC**

The first test at the end of 40-50% coverage of the syllabus and the second test after covering 85-90% of the syllabus.

- Scaled-down marks of the sum of two tests and other assessment methods will be CIE marks for the theory component of IPCC (that is for **25 marks**).
- The student has to secure 40% of 25 marks to qualify in the CIE of the theory component of IPCC.

**Suggested Learning Resources:****Textbooks**

1. Abraham Silberschatz, Peter Baer Galvin, Greg Gagne, Operating System Principles 8th edition, Wiley-India, 2015

**Reference Books**

1. Ann McHoes Ida M Fylnn, Understanding Operating System, Cengage Learning, 6th Edition  
2. D.M Dhamdhare, Operating Systems: A Concept Based Approach 3rd Ed, McGraw- Hill, 2013.

3. P.C.P. Bhatt, An Introduction to Operating Systems: Concepts and Practice 4th Edition, PHI(EEE), 2014.

William Stallings Operating Systems: Internals and Design Principles, 6th Edition, Pearson.

## Table of Content

Sl. No	Programs	CO	PO	BL
1	Develop a c program to implement the Process system calls (fork (), exec(), wait(), create process,terminate process)	CO1	PO1,PO2,PO5	L3
2	Simulate the following CPU scheduling algorithms to find turnaround time and waiting time a) FCFS b) SJF c) Round Robin d) Priority.	CO2	PO1,PO2,PO5	L3
3	Develop a C program to simulate producer-consumer problem using semaphores.	CO2	PO1,PO2,PO5	L3
4	Develop a C program which demonstrates interprocess communication between a reader process and a writer process. Use mkfifo, open, read, write and close APIs in your program.	CO3	PO1,PO2,PO5	L3
5	Develop a C program to simulate Bankers Algorithm for DeadLock Avoidance.	CO3	PO1,PO2,PO5	L3
6	Develop a C program to simulate the following contiguous memory allocation Techniques:  a) Worst fit    b) Best fit    c) First fit.	CO4	PO1,PO2,PO5	L3
7	Develop a C program to simulate page replacement algorithms: a) FIFO b) LRU	CO4	PO1,PO2,PO5	L3
8	Simulate the following File Organization Techniques; a) Single - level directory    b)Two-level directory	CO5	PO1,PO2,PO5	L3
9	Develop a C program to simulate the Linked file allocation strategies.	CO5	PO1,PO2,PO5	L3
10	Develop a C program to simulate the SCAN disk scheduling algorithm.	CO6	PO1,PO2,PO5	L3



## Program-1

**Develop a c program to implement the Process system calls (fork (), exec (), wait (), create process, terminate process)**

```
#include<stdio.h> // printf()
#include<stdlib.h> // exit()
#include<sys/types.h> // pid_t
#include<sys/wait.h> // wait()
#include<unistd.h> // fork

int main(int argc, char **argv)
{
    pid_t pid;
    pid = fork();
    if(pid==0)
    {
        printf("It is the child process and pid is %d\n",getpid());
        int i=0;
        for(i=0;i<8;i++)
        {
            printf("%d\n",i);
        }
        exit(0);
    }
    else if(pid > 0)
    {
        printf("It is the parent process and pid is %d\n",getpid());
        int status;
        wait(&status);
        printf("Child is reaped\n");
    }
    else
    {
        printf("Error in forking..\n");
        exit(EXIT_FAILURE);
    }
    return 0;
}
```

```
It is the parent process and pid is 4498
It is the child process and pid is 4499
0
1
2
3
4
5
6
7
Child is reaped
```

**Output:**

---

## Program-2

**Simulate the following CPU scheduling algorithms to find turnaround time and waiting time**

**a) FCFS**

```
#include<stdio.h>
int main()
{
    int n,bt[20],wt[20],tat[20],avwt=0,avtat=0,i,j;
    printf("Enter total number of processes(maximum 20): ");
    scanf("%d",&n);
    printf("\nEnter Process Burst Time:\n");
    for(i=0;i<n;i++)
    {
        printf("P[%d]: ",i+1);
        scanf("%d",&bt[i]);
    }
    wt[0]=0;
    for(i=1;i<n;i++)
    {
        wt[i]=0;
        for(j=0;j<i;j++)
            wt[i]+=bt[j];
    }

    printf("\nProcess\t\tBurst Time\tWaiting Time\tTurnaround Time");
    //calculating turnaround time
    for(i=0;i<n;i++)
    {
        tat[i]=bt[i]+wt[i];
        avwt+=wt[i];
        avtat+=tat[i];
        printf("\nP[%d]\t\t%d\t\t%d\t\t%d",i+1,bt[i],wt[i],tat[i]);
    }
    avwt/=i;
    avtat/=i;
    printf("\n\nAverage Waiting Time:%d",avwt);
    printf("\n\nAverage Turnaround Time:%d",avtat);
    return 0;
}
```

**Output:**

```

Enter total number of processes(maximum 20): 4
Enter Process Burst Time:
P[1]: 5
P[2]: 8
P[3]: 2
P[4]: 7

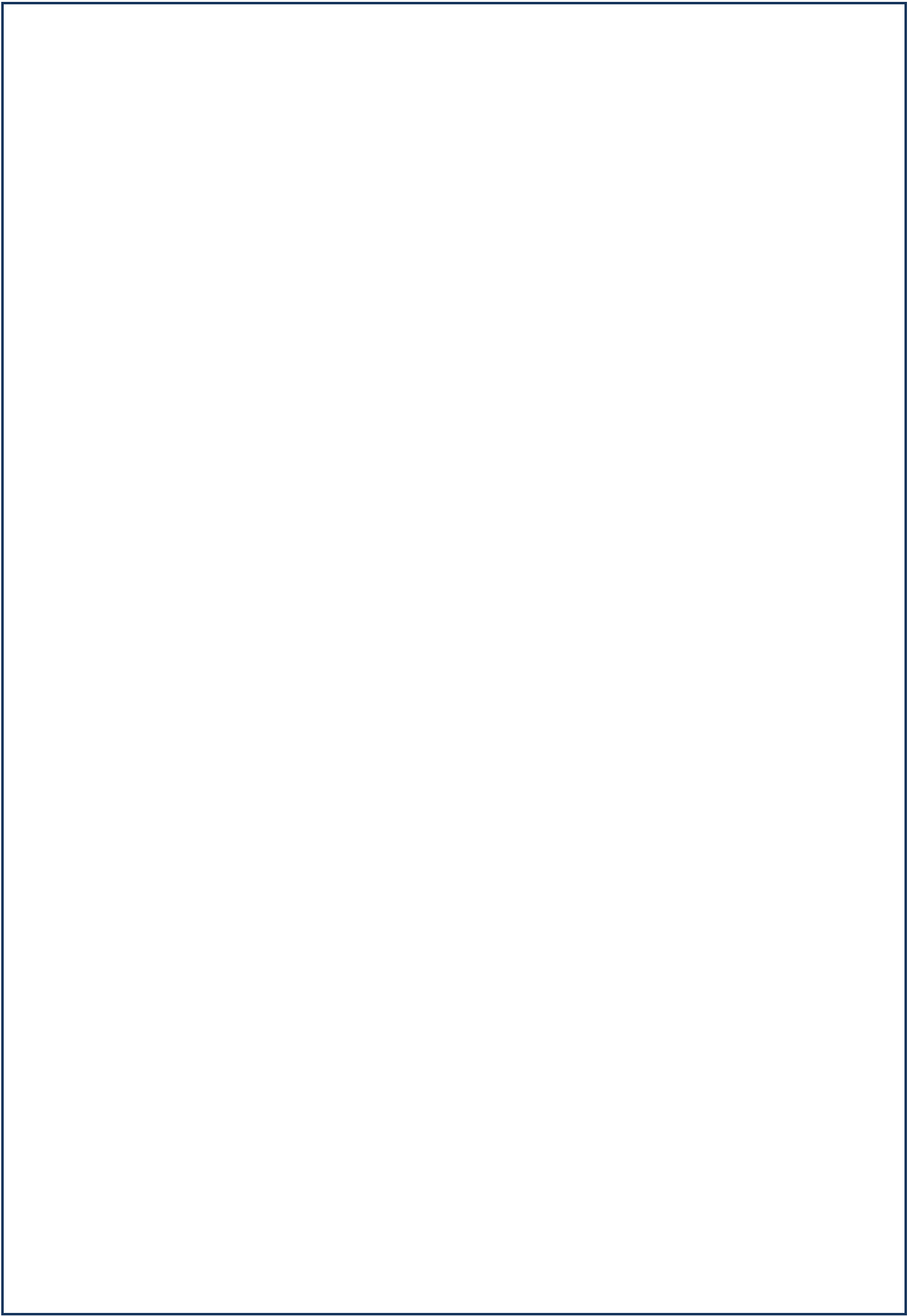
```

Process	Burst Time	Waiting Time	Turnaround Time
P[1]	5	0	5
P[2]	8	5	13
P[3]	2	13	15
P[4]	7	15	22

```

Average Waiting Time:8
Average Turnaround Time:13

```



**b) SJF**

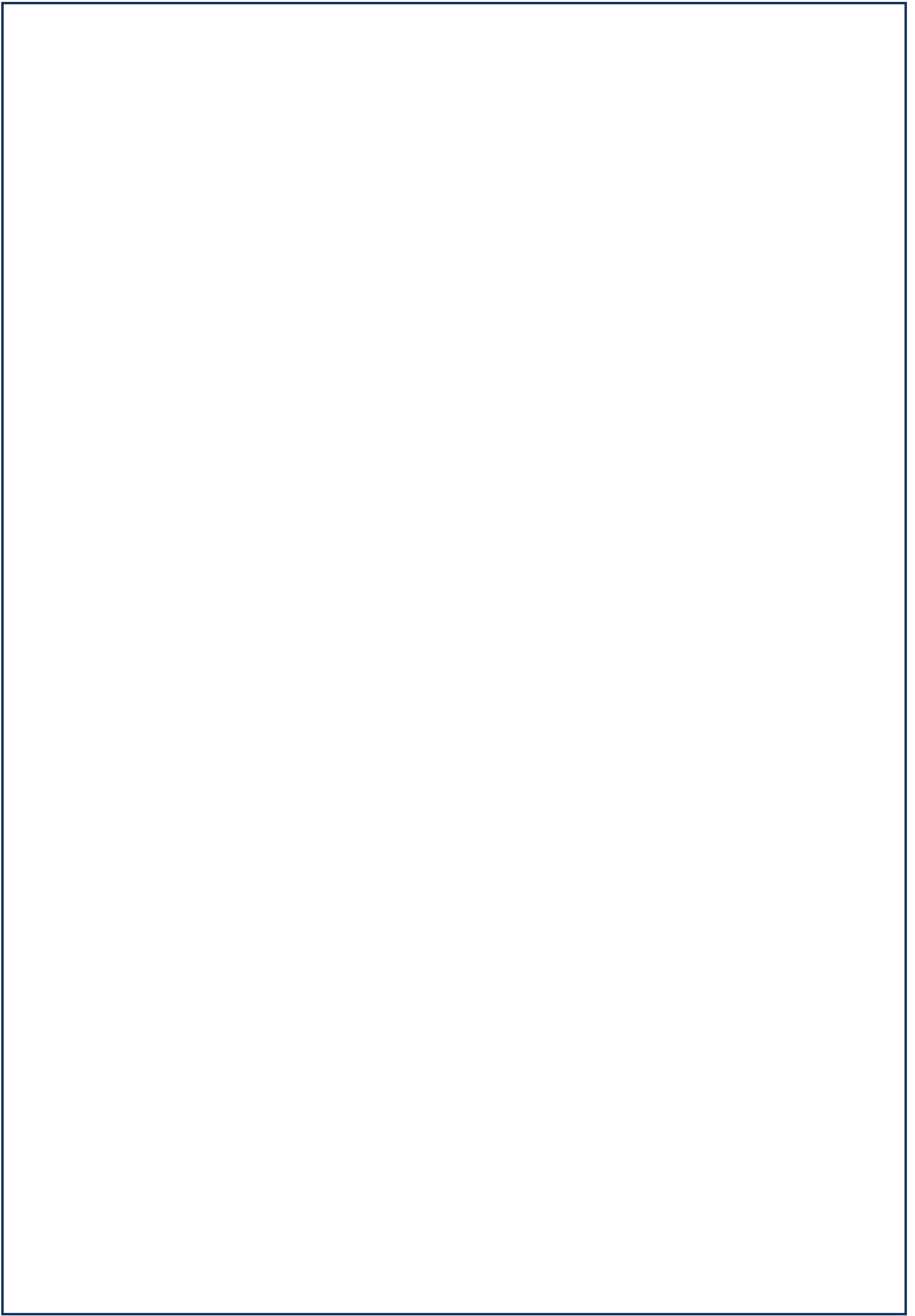
```
#include<stdio.h>
int main()
{
    int bt[20],p[20],wt[20],tat[20],i,j,n,total=0,pos,temp;
    float avg_wt,avg_tat;
    printf("Enter number of process: ");
    scanf("%d",&n);
    printf("\nEnter Burst Time:\n");
    for(i=0;i<n;i++)
    {
        printf("p%d: ",i+1);
        scanf("%d",&bt[i]);
        p[i]=i+1;
    }
    for(i=0;i<n;i++)
    {
        pos=i;
        for(j=i+1;j<n;j++)
        {
            if(bt[j]<bt[pos])
                pos=j;
        }
        temp=bt[i];
        bt[i]=bt[pos];
        bt[pos]=temp;
        temp=p[i];
        p[i]=p[pos];
        p[pos]=temp;
    }
    wt[0]=0;
    for(i=1;i<n;i++)
    {
        wt[i]=0;
        for(j=0;j<i;j++)
            wt[i]+=bt[j];
        total+=wt[i];
    }
    avg_wt=(float)total/n;
    total=0;
    printf("\nProcess\t Burst Time \tWaiting Time\tTurnaround Time");
    for(i=0;i<n;i++)
    {
        tat[i]=bt[i]+wt[i];
        total+=tat[i];

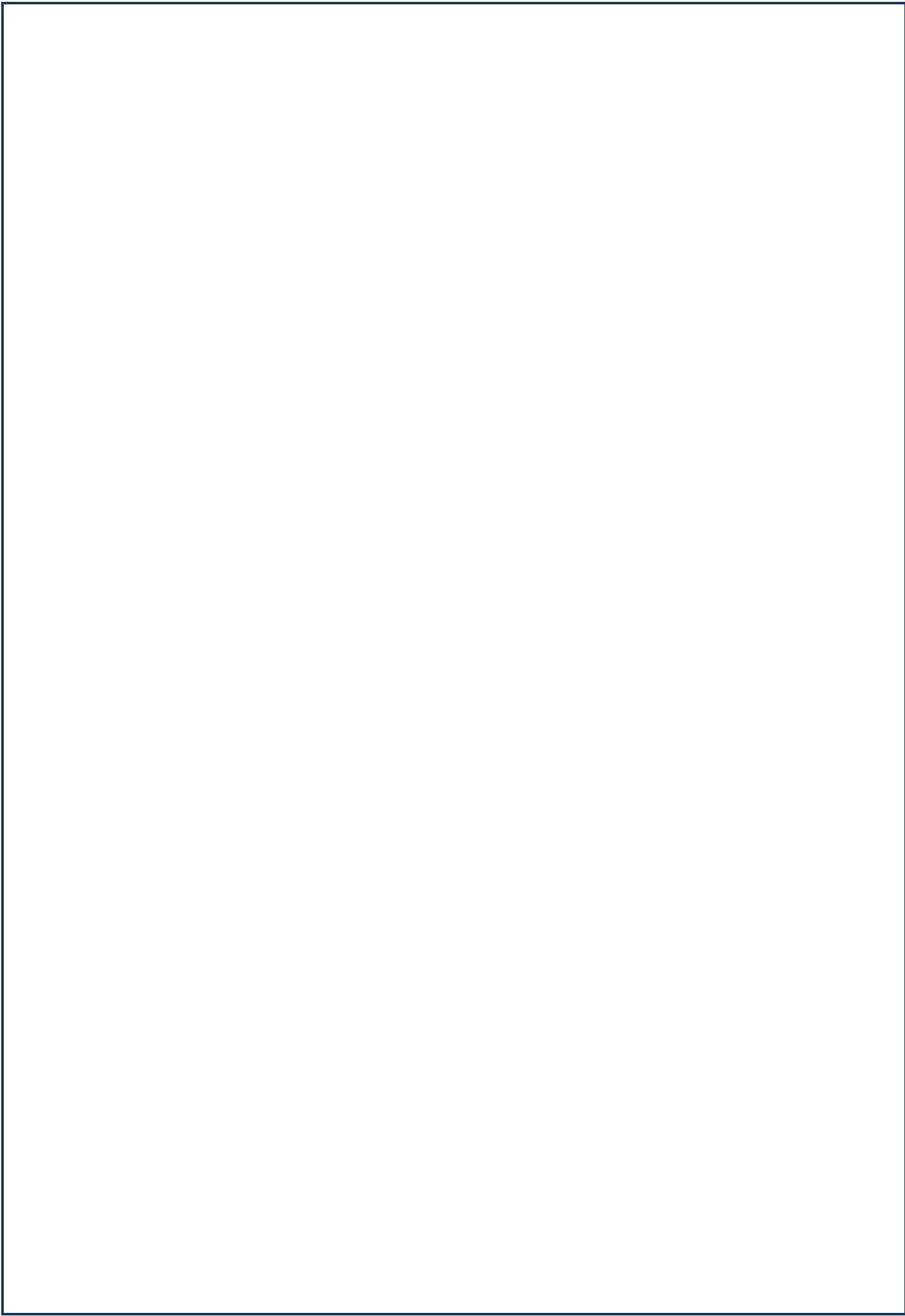
        printf("\np%d\t\t %d\t\t %d\t\t%d",p[i],bt[i],wt[i],tat[i]);
    }
    avg_tat=(float)total/n;
    printf("\n\nAverage Waiting Time=%f",avg_wt);
    printf("\n\nAverage Turnaround Time=%f\n",avg_tat);
    return 0;
}
```

**Output:**

```
Enter number of process: 4
Enter Burst Time:
p1: 5
p2: 4
p3: 8
p4: 2
Process    Burst Time    Waiting Time    Turnaround Time
p4         2             0              2
p2         4             2              6
p1         5             6             11
p3         8             11            19

Average Waiting Time=4.750000
Average Turnaround Time=9.500000
```





### c) Round Robin

```
#include<stdio.h>
int main()
{
    int count,j,n,time,remain,flag=0,time_quantum;
    int wait_time=0,turnaround_time=0,at[10],bt[10],rt[10];
    printf("Enter Total Process:\t ");
    scanf("%d",&n);
    remain=n;
    for(count=0;count<n;count++)
    {
        printf("Enter Arrival Time and Burst Time for Process Process Number %d :",count+1);
        scanf("%d",&at[count]);
        scanf("%d",&bt[count]);
        rt[count]=bt[count];
    }
    printf("Enter Time Quantum:\t");
    scanf("%d",&time_quantum);
    printf("\n\nProcess\t|Turnaround Time|Waiting Time\n\n");
    for(time=0,count=0;remain!=0;)
    {
        if(rt[count]<=time_quantum && rt[count]>0)
        {
            time+=rt[count];
            rt[count]=0;
            flag=1;
        }
        else if(rt[count]>0)

        {
            rt[count]-=time_quantum;
            time+=time_quantum;
        }
        if(rt[count]==0 && flag==1)
        {
            remain--;
            printf("P[%d]\t|\t%d\t|\t%d\n",count+1,time-at[count],time-at[count]-bt[count]);
            wait_time+=time-at[count]-bt[count];
            turnaround_time+=time-at[count];
            flag=0;
        }
        if(count==n-1)
            count=0;
        else if(at[count+1]<=time)
            count++;
        else
            count=0;
    }
    printf("\nAverage Waiting Time= %f\n",wait_time*1.0/n);
    printf("Avg Turnaround Time = %f",turnaround_time*1.0/n);

    return 0;
}
```

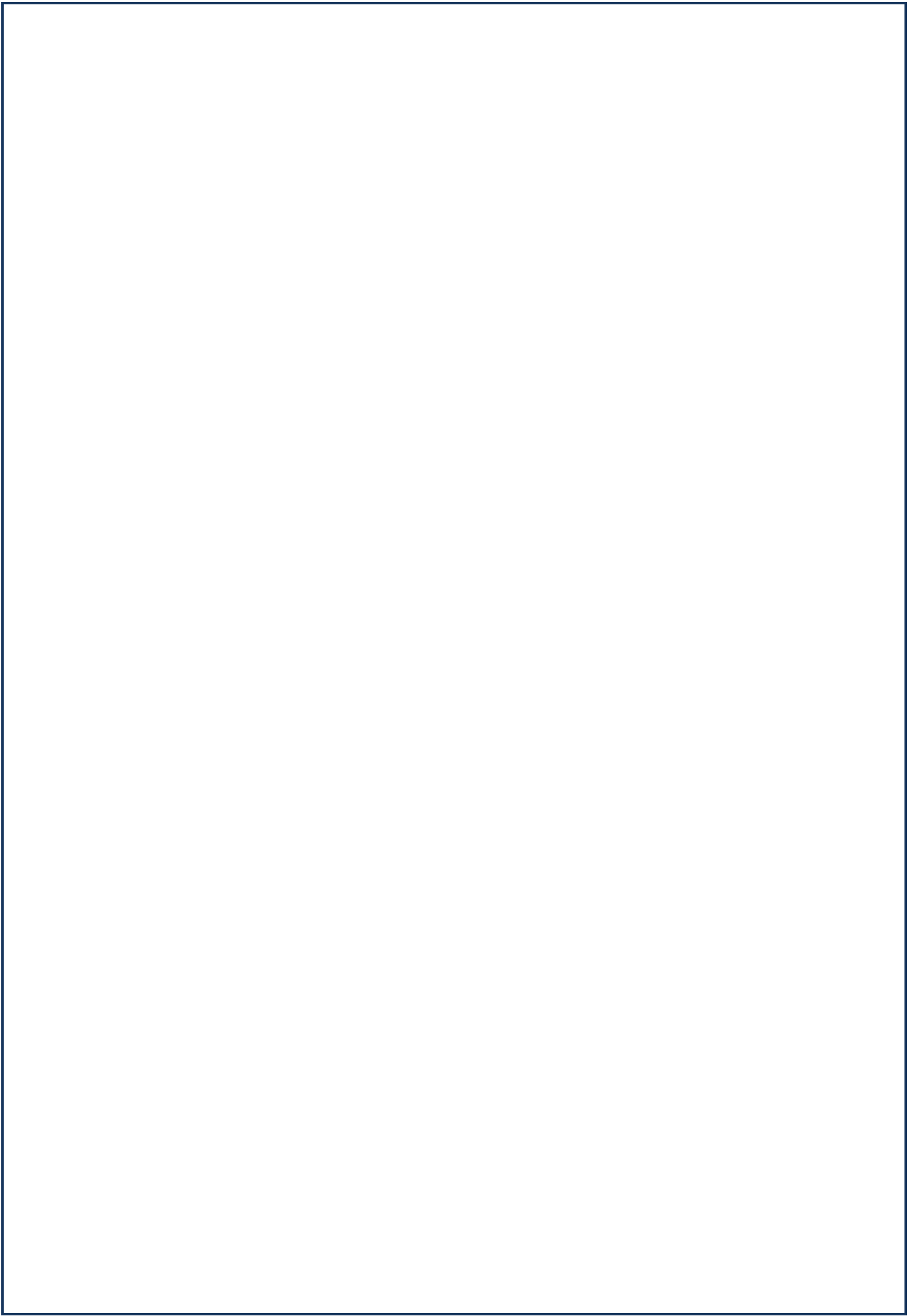


## Output:

```
Enter Total Process:      5
Enter Arrival Time and Burst Time for Process Process Number 1 :4
5
Enter Arrival Time and Burst Time for Process Process Number 2 :2
8
Enter Arrival Time and Burst Time for Process Process Number 3 :6
4
Enter Arrival Time and Burst Time for Process Process Number 4 :1
2
Enter Arrival Time and Burst Time for Process Process Number 5 :0
7
Enter Time Quantum: 2
Process |Turnaround Time|Waiting Time

P[4]    |    11    |    9
P[1]    |    11    |    6
P[3]    |    13    |    9
P[2]    |    21    |   13
P[5]    |    26    |   19

Average Waiting Time= 11.200000
Avg Turnaround Time = 16.400000
```



#### d) Priority

```
#include<stdio.h>

int main()
{
    int bt[20],p[20],wt[20],tat[20],pr[20],i,j,n,total=0,pos,temp,avg_wt,avg_tat;
    printf("Enter Total Number of Process:");
    scanf("%d",&n);

    printf("\nEnter Burst Time and Priority\n");
    for(i=0;i<n;i++)
    {
        printf("\nP[%d]\n",i+1);
        printf("Burst Time:");
        scanf("%d",&bt[i]);
        printf("Priority:");
        scanf("%d",&pr[i]);
        p[i]=i+1;
    }

    for(i=0;i<n;i++)
    {
        pos=i;
        for(j=i+1;j<n;j++)
        {
            if(pr[j]<pr[pos])
                pos=j;
        }
        temp=pr[i];
        pr[i]=pr[pos];
        pr[pos]=temp;

        temp=bt[i];
        bt[i]=bt[pos];
        bt[pos]=temp;

        temp=p[i];
        p[i]=p[pos];
        p[pos]=temp;
    }

    wt[0]=0;
    for(i=1;i<n;i++)
    {
        wt[i]=0;

        for(j=0;j<i;j++)
            wt[i]+=bt[j];

        total+=wt[i];
    }
    avg_wt=total/n;
    total=0;
```

```

printf("\nProcess\t Burst Time \tWaiting Time\tTurnaround Time");
for(i=0;i<n;i++)
{
    tat[i]=bt[i]+wt[i];
    total+=tat[i];
    printf("\nP[%d]\t\t %d\t\t %d\t\t%d",p[i],bt[i],wt[i],tat[i]);
}

avg_tat=total/n;
printf("\n\nAverage Waiting Time=%d",avg_wt);
printf("\n\nAverage Turnaround Time=%d\n",avg_tat);
return 0;
}

```

## Output:

```

Enter Total Number of Process:5
Enter Burst Time and Priority

P[1]
Burst Time:4
Priority:2
P[2]
Burst Time:8
Priority:1
P[3]
Burst Time:9
Priority:4
P[4]
Burst Time:7
Priority:3
P[5]
Burst Time:7
Priority:5

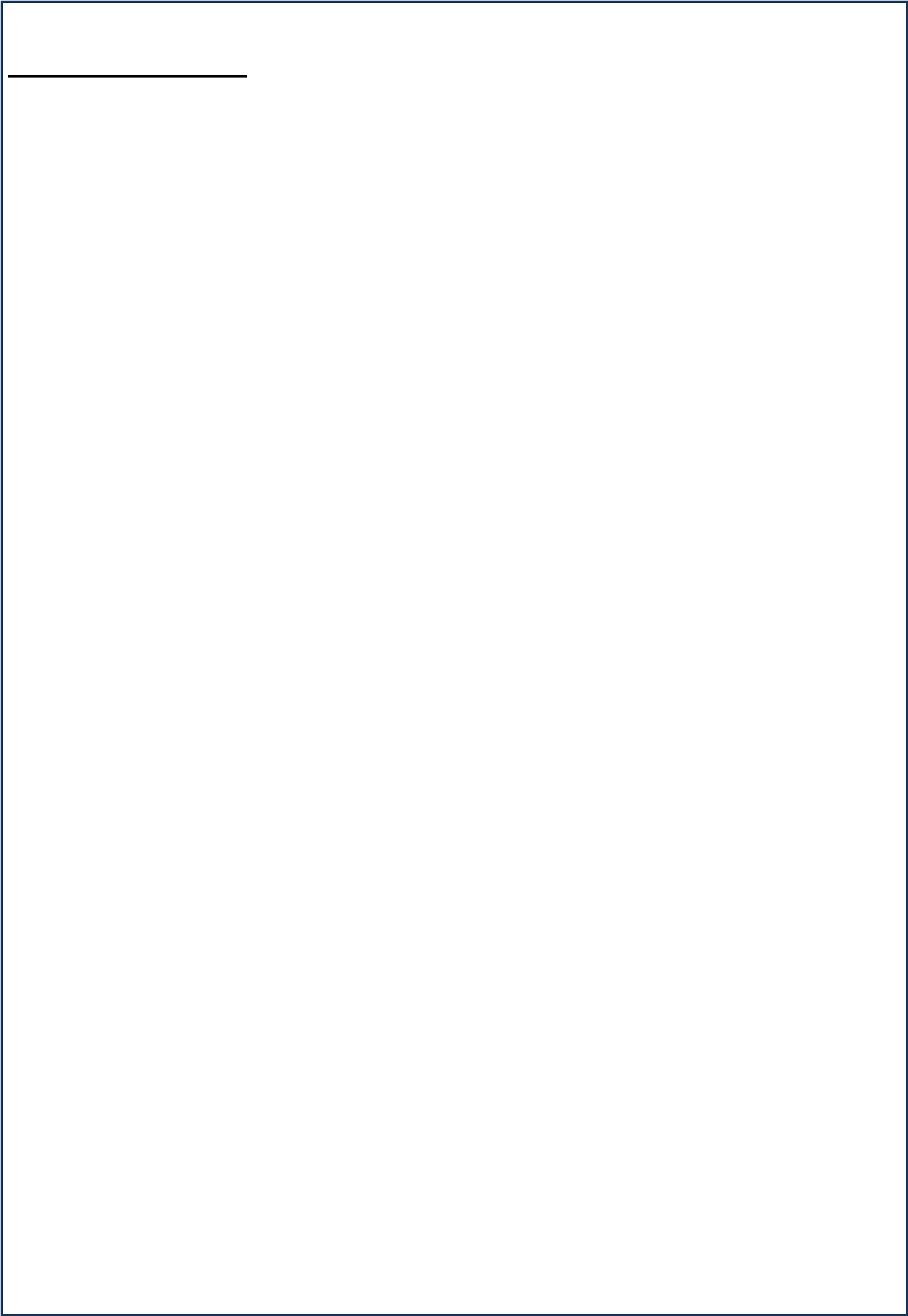
```

Process	Burst Time	Waiting Time	Turnaround Time
P[2]	8	0	8
P[1]	4	8	12
P[4]	7	12	19
P[3]	9	19	28
P[5]	7	28	35

```

Average Waiting Time=13
Average Turnaround Time=20

```



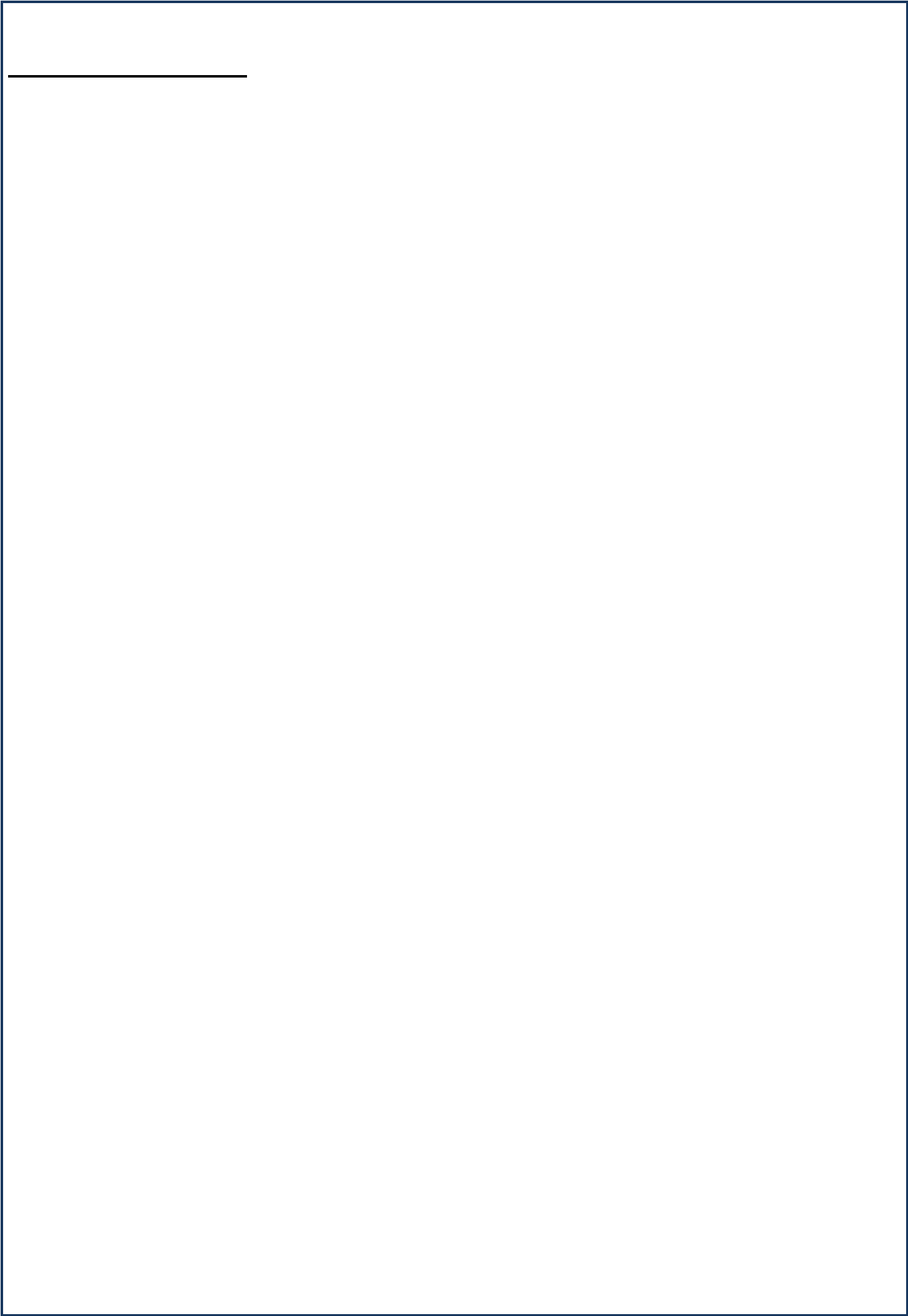
### Program-3

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

```
#include<stdio.h>
void main()
{
    int buffer[10], bufsize, in, out, produce, consume, choice=0;
    in = 0;
    out = 0;
    bufsize = 10;
    while(choice !=3)
    {
        printf("\n 1. Produce \t 2. Consume \t 3. Exit");
        printf("\n Enter your choice: ");
        scanf("%d", &choice);
        switch(choice) {
            case 1: if((in+1)%bufsize==out)
                printf("\n Buffer is Full");
            else
            {
                printf("\nEnter the value: ");
                scanf("%d", &produce);
                buffer[in] = produce;
                in = (in+1)%bufsize;
            }
            break;
            case 2: if(in == out)
                printf("\nBuffer is Empty");
            else
            {
                consume = buffer[out];
                printf("\nThe consumed value is %d", consume);
                out = (out+1)%bufsize;
            }
            break;
        } } }
```

**Output:**

```
1. Produce   2. Consume   3. Exit
Enter your choice: 2
Buffer is Empty
1. Produce   2. Consume   3. Exit
Enter your choice: 1
Enter the value: 56
1. Produce   2. Consume   3. Exit
Enter your choice: 2
The consumed value is 56
1. Produce   2. Consume   3. Exit
Enter your choice:
```



### Program-4

**Develop a C program which demonstrates inter-process communication between a reader process and a writer process. Use mkfifo, open, read, write and close APIs in your program.**

**/\*Writer Process\*/**

```
#include <stdio.h>
#include <fcntl.h>
#include <sys/stat.h>
#include <sys/types.h>
#include <unistd.h>
int main()
{
    int fd;
    char buf[1024];
    /* create the FIFO (named pipe) */
    char * myfifo = "/tmp/myfifo";
    mkfifo(myfifo, 0666);
    printf("Run Reader process to read the FIFO File\n");
    fd = open(myfifo, O_WRONLY);
    write(fd, "Hi", sizeof("Hi"));
    /* write "Hi" to the FIFO */
    close(fd);
    unlink(myfifo); /* remove the FIFO */
    return 0;
}
```

**/\* Reader Process\*/**

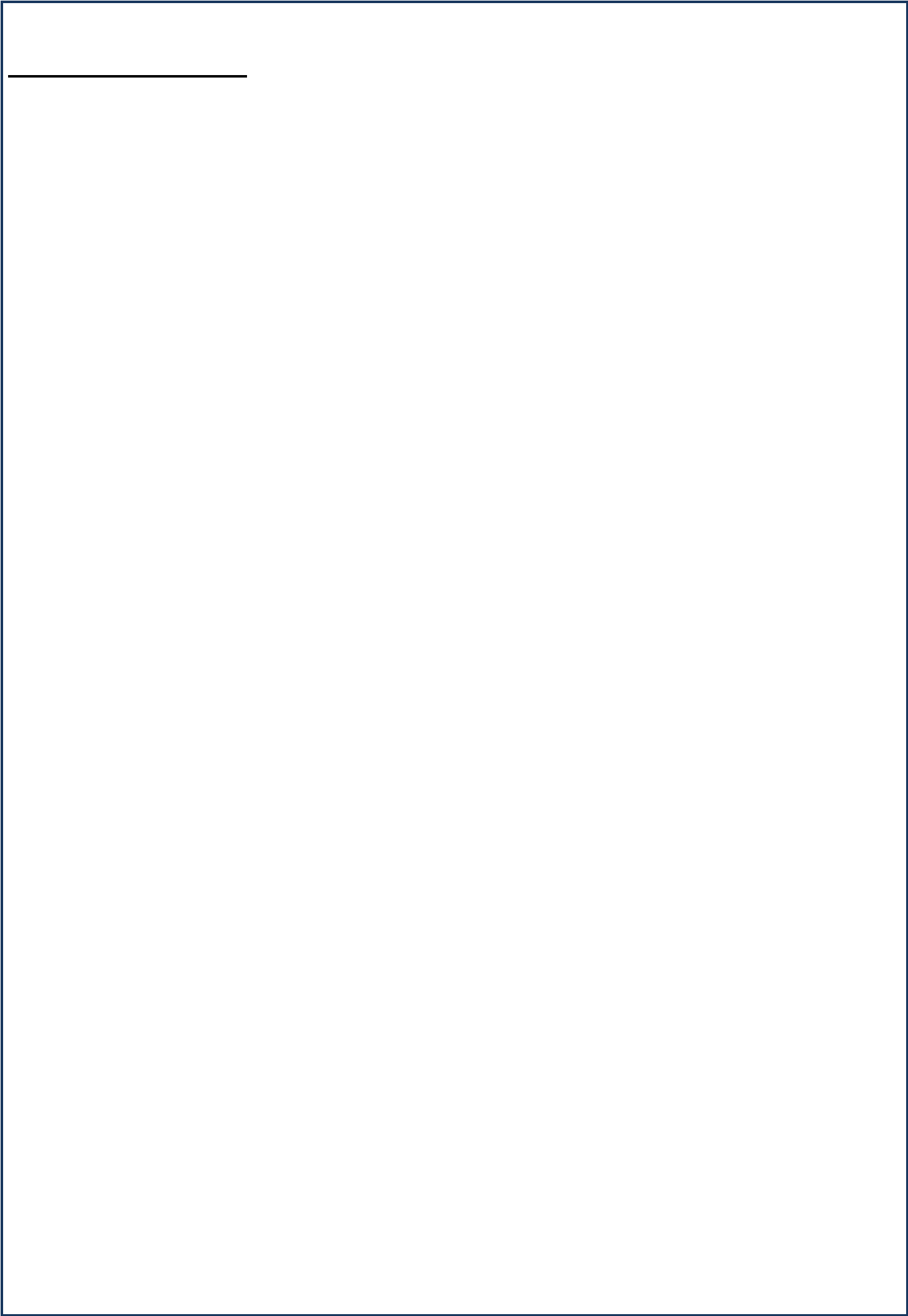
```
#include <fcntl.h>
#include <sys/stat.h>
#include <sys/types.h>
#include <unistd.h>
#include <stdio.h>
#define MAX_BUF 1024
int main()
{
    int fd;
    /* A temp FIFO file is not created in reader */
    char *myfifo = "/tmp/myfifo";
    char buf[MAX_BUF];
    /* open, read, and display the message from the FIFO */
    fd = open(myfifo, O_RDONLY);
    read(fd, buf, MAX_BUF);
    printf("Writer: %s\n", buf);
    close(fd);
    return 0;
}
```



### Instructions for Execution:

1. Run Reader Process
2. Then Run Writer Process

```
Writer: Hi
```



## Program-5

**Develop a C program to simulate Bankers Algorithm for DeadLock Avoidance.**

```
#include <stdio.h>
#include <stdlib.h>
int main()
{
    int Max[10][10], need[10][10], alloc[10][10], avail[10], completed[10], safeSequence[10];
    int p, r, i, j, process, count;
    count = 0;

    printf("Enter the no of processes : ");
    scanf("%d", &p);

    for(i = 0; i < p; i++)
        completed[i] = 0;

    printf("\n\nEnter the no of resources : ");
    scanf("%d", &r);

    printf("\n\nEnter the Max Matrix for each process : ");
    for(i = 0; i < p; i++)
    {
        printf("\nFor process %d : ", i + 1);
        for(j = 0; j < r; j++)
            scanf("%d", &Max[i][j]);
    }

    printf("\n\nEnter the allocation for each process : ");
    for(i = 0; i < p; i++)
    {
        printf("\nFor process %d : ", i + 1);
        for(j = 0; j < r; j++)
            scanf("%d", &alloc[i][j]);
    }

    printf("\n\nEnter the Available Resources : ");
    for(i = 0; i < r; i++)
        scanf("%d", &avail[i]);

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

        for(j = 0; j < r; j++)
            need[i][j] = Max[i][j] - alloc[i][j];

    do
    {
        printf("\n Max matrix:\tAllocation matrix:\n");

        for(i = 0; i < p; i++)
        {
            for(j = 0; j < r; j++)
                printf("%d ", Max[i][j]);
            printf("\t\t");
        }
    }
```

```

        for( j = 0; j < r; j++)

            printf("%d ", alloc[i][j]);
        printf("\n");
    }

    process = -1;

    for(i = 0; i < p; i++)
    {
        if(completed[i] == 0)//if not completed
        {
            process = i ;
            for(j = 0; j < r; j++)
            {
                if(avail[j] < need[i][j])
                {
                    process = -1;
                    break;
                }
            }
        }
        if(process != -1)
            break;
    }

    if(process != -1)
    {
        printf("\nProcess %d runs to completion!", process + 1);
        safeSequence[count] = process + 1;
        count++;
        for(j = 0; j < r; j++)
        {
            avail[j] += alloc[process][j];
            alloc[process][j] = 0;
            Max[process][j] = 0;
            completed[process] = 1;
        }
    }
}
while(count != p && process != -1);

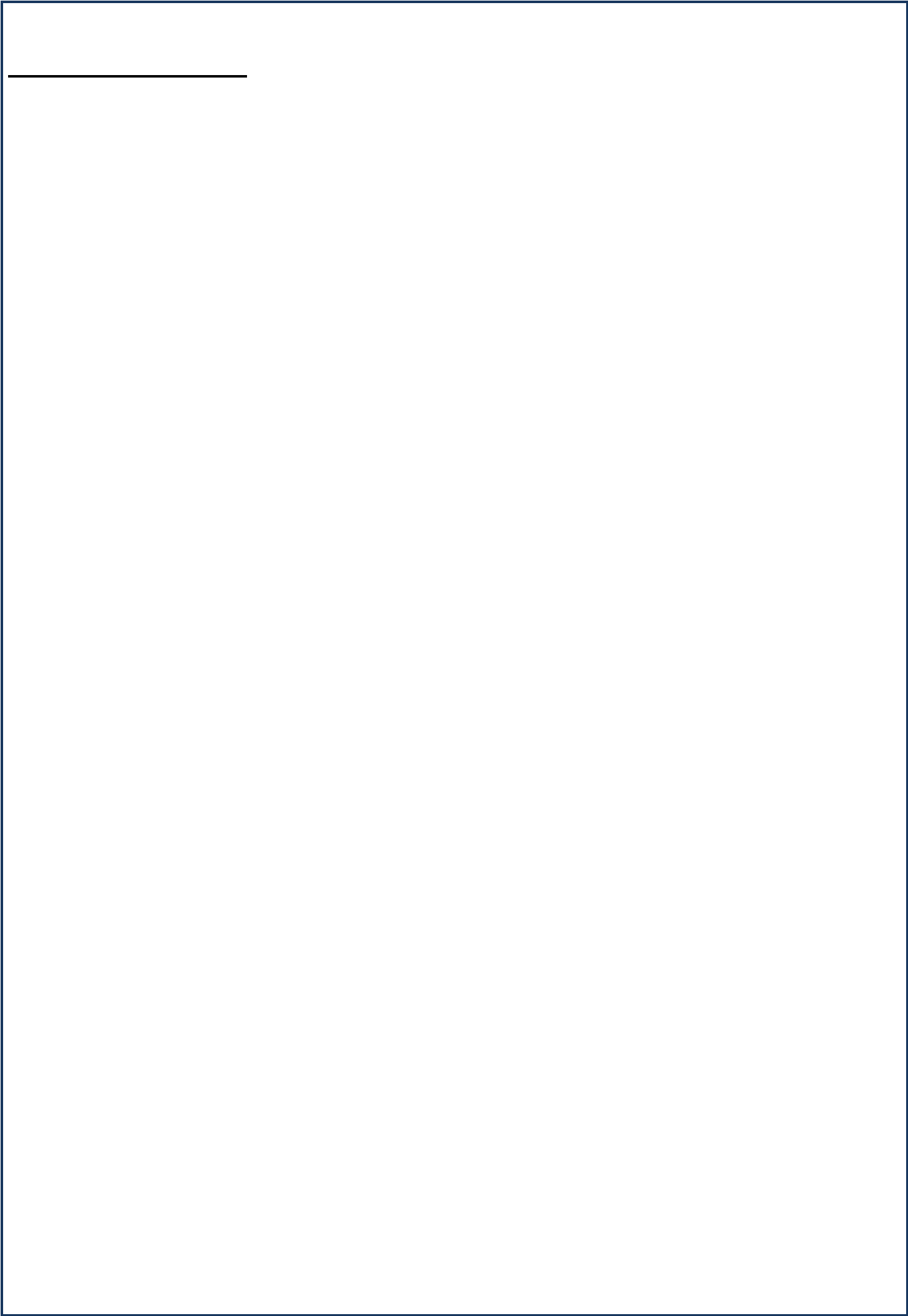
if(count == p)
{
    printf("\nThe system is in a safe state!!\n");
    printf("Safe Sequence : < ");
    for( i = 0; i < p; i++)
        printf("%d ", safeSequence[i]);
    printf(">\n");
}
else
    printf("\nThe system is in an unsafe state!!");
}

```

## Output:

```
Enter the no of processes : 4
Enter the no of resources : 3
Enter the Max Matrix for each process :
For process 1 : 4
4
4
For process 2 : 2
3
4
For process 3 : 5
4
2
For process 4 : 7
4
1
Enter the allocation for each process :
For process 1 : 1
0
2
For process 2 : 2
0
0
For process 3 : 1
3
5
For process 4 : 4
5
2
Enter the Available Resources : 1
2
4
Max matrix: Allocation matrix:
4 4 4      1 0 2
2 3 4      2 0 0
5 4 2      1 3 5
7 4 1      4 5 2

The system is in an unsafe state!!
```



## Program-6

**Develop a C program to simulate the following contiguous memory allocation Techniques**

**a) Worst fit**

```
#include<stdio.h>
int main()
{
    int fragments[10], blocks[10], files[10];
    int m, n, number_of_blocks, number_of_files, temp, top = 0;
    static int block_arr[10], file_arr[10];
    printf("\nEnter the Total Number of Blocks:\t");
    scanf("%d",&number_of_blocks);
    printf("Enter the Total Number of Files:\t");
    scanf("%d",&number_of_files);
    printf("\nEnter the Size of the Blocks:\n");
    for(m = 0; m < number_of_blocks; m++)
    {
        printf("Block No. [%d]:\t", m + 1);
        scanf("%d", &blocks[m]);
    }
    printf("Enter the Size of the Files:\n");

    for(m = 0; m < number_of_files; m++)
    {
        printf("File No. [%d]:\t", m + 1);
        scanf("%d", &files[m]);
    }

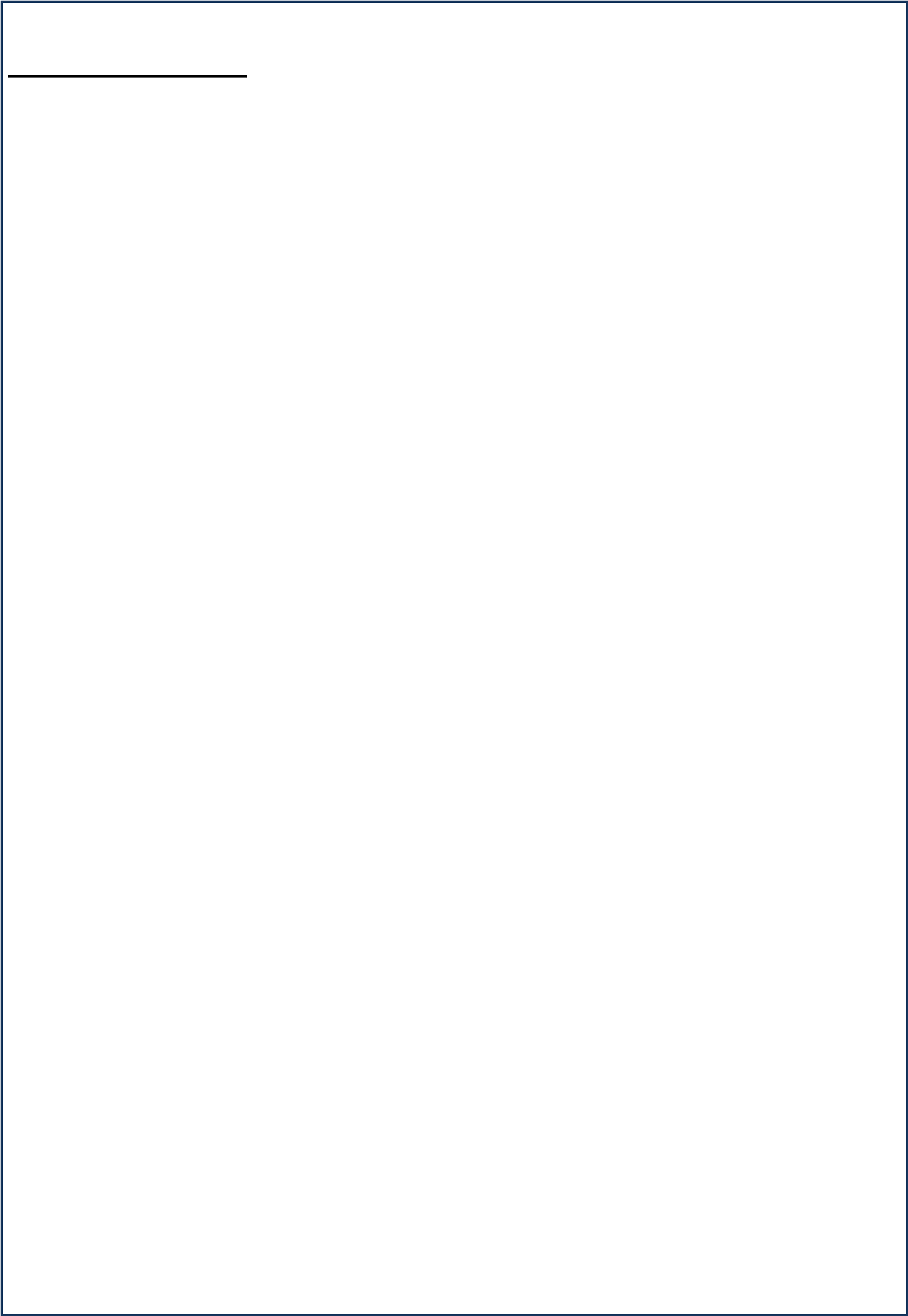
    for(m = 0; m < number_of_files; m++)
    {
        for(n = 0; n < number_of_blocks; n++)
        {
            if(block_arr[n] != 1)
            {
                temp = blocks[n] - files[m];
                if(temp >= 0)
                {
                    if(top < temp)
                    {
                        file_arr[m] = n;
                        top = temp;
                    }
                }
            }
            fragments[m] = top;
            block_arr[file_arr[m]] = 1;
            top = 0;
        }
    }
    printf("\nFile Number\tFile Size\tBlock Number\tBlock Size\tFragment");
    for(m = 0; m < number_of_files; m++)
    {
        printf("\n%d\t\t%d\t\t%d\t\t%d\t\t%d", m, files[m], file_arr[m],
            blocks[file_arr[m]], fragments[m]);
    }
}
```

```
printf("\n");  
  
    return 0;  
}
```

### Output:

```
Enter the Total Number of Blocks:  5  
Enter the Total Number of Files:   4  
Enter the Size of the Blocks:  
Block No.[1]:  5  
Block No.[2]:  4  
Block No.[3]:  3  
Block No.[4]:  6  
Block No.[5]:  7  
Enter the Size of the Files:  
File No.[1]:   1  
File No.[2]:   3  
File No.[3]:   5  
File No.[4]:   3  
File Number  File Size  Block Number  Block Size  Fragment  
0           1          4           7           6  
1           3           0           5           0  
2           5           0           5           0  
3           3           0           5           0
```





**b) Best Fit**

```
#include<stdio.h>

void main()
{
    int fragment[20],b[20],p[20],i,j,nb,np,temp,lowest=9999;
    static int barray[20],parray[20];

    printf("\n\t\tMemory Management Scheme - Best Fit");
    printf("\nEnter the number of blocks:");
    scanf("%d",&nb);
    printf("Enter the number of processes:");
    scanf("%d",&np);

    printf("\nEnter the size of the blocks:-\n");
    for(i=1;i<=nb;i++)
    {
        printf("Block no.%d:",i);
        scanf("%d",&b[i]);
    }

    printf("\nEnter the size of the processes :-\n");
    for(i=1;i<=np;i++)
    {
        printf("Process no.%d:",i);
        scanf("%d",&p[i]);
    }

    for(i=1;i<=np;i++)
    {
        for(j=1;j<=nb;j++)
        {
            if(barray[j]!=1)
            {
                temp=b[j]-p[i];
                if(temp>=0)
                {
                    if(lowest>temp)
                    {
                        parray[i]=j;
                        lowest=temp;
                    }
                }
            }
        }

        fragment[i]=lowest;
        barray[parray[i]]=1;
        lowest=10000;
    }

    printf("\nProcess_no\tProcess_size\tBlock_no\tBlock_size\tFragment");
    for(i=1;i<=np && parray[i]!=0;i++)
        printf("\n%d\t%d\t%d\t%d\t%d",i,p[i],parray[i],b[parray[i]],fragment[i]);
}
```

## output

Memory Management Scheme - Best Fit

Enter the number of blocks:5

Enter the number of processes:4

Enter the size of the blocks:-

Block no.1:10

Block no.2:15

Block no.3:5

Block no.4:9

Block no.5:3

Enter the size of the processes :-

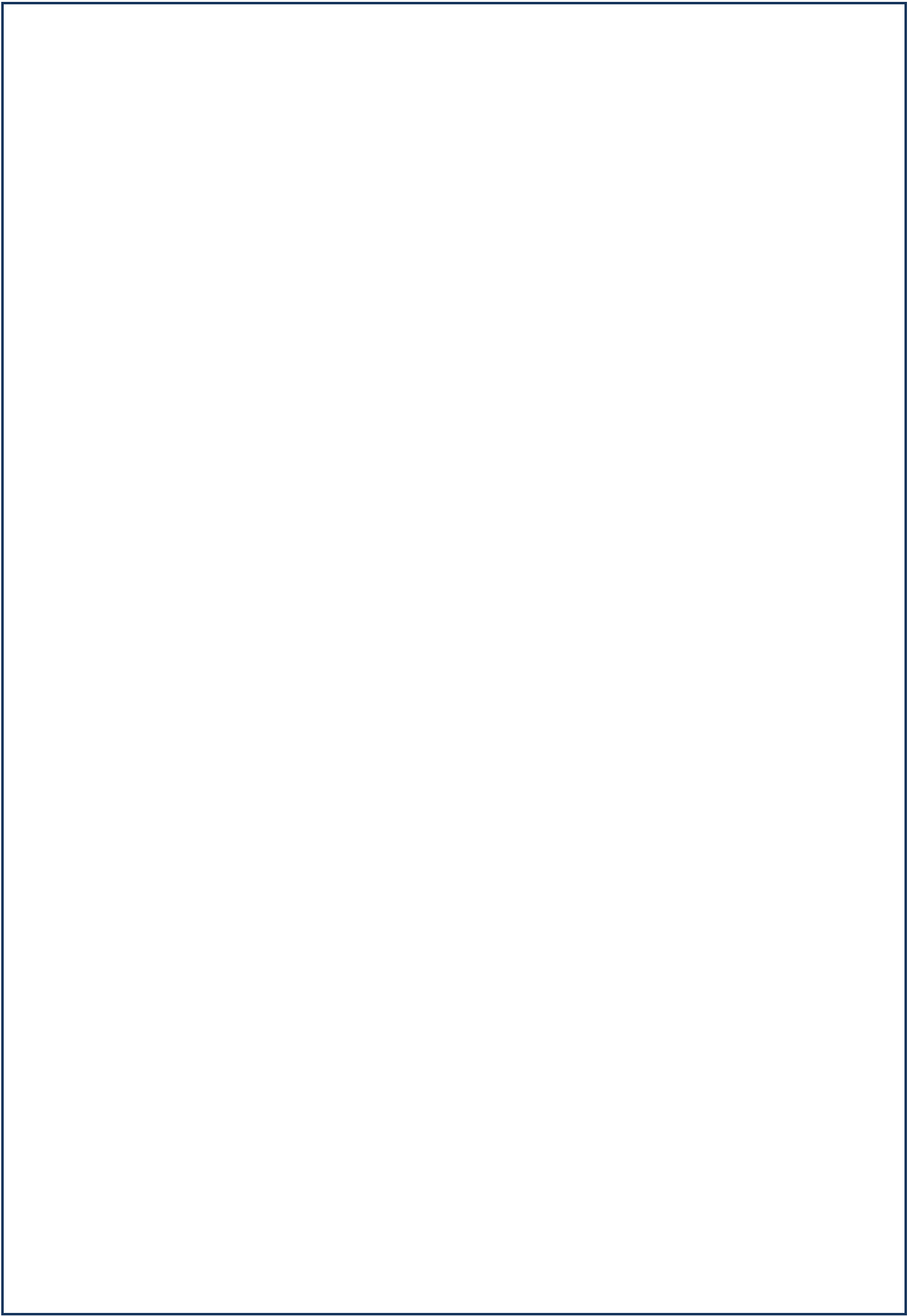
Process no.1:1

Process no.2:4

Process no.3:7

Process no.4:12

Process_no	Process_size	Block_no	Block_size	Fragment
1	1	5	3	2
2	4	3	5	1
3	7	4	9	2
4	12	2	15	3



### c) First Fit

```
#include<stdio.h>
#define max 25
void main()
{
    int frag[max],b[max],f[max],i,j,nb,nf,temp,highest=0;
    static int bf[max],ff[max];
    printf("\n\tMemory Management Scheme - First Fit");
    printf("\nEnter the number of blocks:");
    scanf("%d",&nb);
    printf("Enter the number of files:");
    scanf("%d",&nf);
    printf("\nEnter the size of the blocks:-\n");
    for(i=1;i<=nb;i++)
    {
        printf("Block %d:",i);
        scanf("%d",&b[i]);
    }
    printf("Enter the size of the files :-\n");
    for(i=1;i<=nf;i++)
    {
        printf("File %d:",i);
        scanf("%d",&f[i]);
    }
    for(i=1;i<=nf;i++)
    {
        for(j=1;j<=nb;j++)
        {
            if(bf[j]!=1) //if bf[j] is not allocated
            {
                temp=b[j]-f[i];
                if(temp>=0)
                if(highest<temp)
                {
                    ff[i]=j;
                    highest=temp;
                }
            }
        }
        frag[i]=highest;
        bf[ff[i]]=1;
        highest=0;
    }
    printf("\nFile_no:\tFile_size :\tBlock_no:\tBlock_size:\tFragement");
    for(i=1;i<=nf;i++)
    printf("\n%d\t%d\t%d\t%d\t%d",
    i,f[i],ff[i],b[ff[i]],frag[i]);
}
```

## Output:

```
Memory Management Scheme - First Fit
Enter the number of blocks:3
Enter the number of files:2
Enter the size of the blocks:-
Block 1:5
Block 2:2
Block 3:7
Enter the size of the files :-
File 1:2
File 2:5
File_no:   File_size : Block_no:   Block_size: Fragement
1         2         3         7         5
2         5         0         0         0
```

---

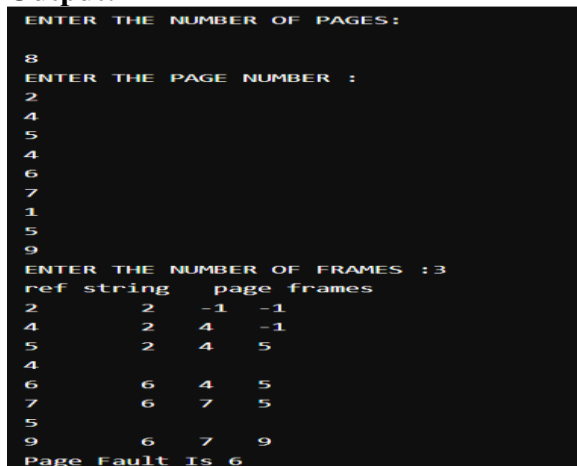
## Program-7

### Develop a C program to simulate page replacement algorithms

#### a) FIFO

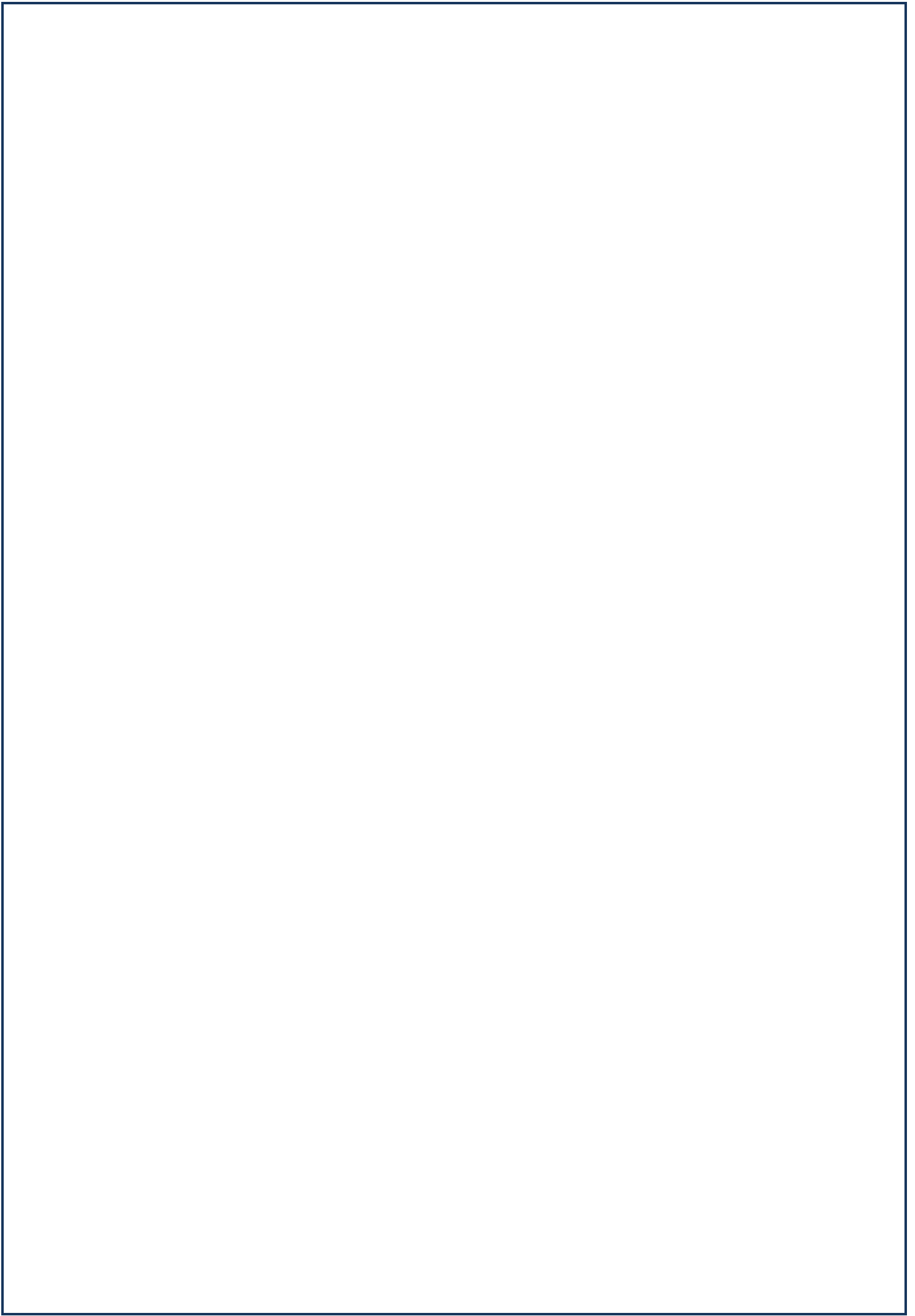
```
#include<stdio.h>
int main()
{
    int i,j,n,a[50],frame[10],no,k,avail,count=0;
    printf("\n ENTER THE NUMBER OF PAGES:\n");
    scanf("%d",&n);
    printf("\n ENTER THE PAGE NUMBER :\n");
    for(i=1;i<=n;i++)
        scanf("%d",&a[i]);
    printf("\n ENTER THE NUMBER OF FRAMES :");
    scanf("%d",&no);
    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:
8
ENTER THE PAGE NUMBER :
2
4
5
4
6
7
1
5
9
ENTER THE NUMBER OF FRAMES :3
ref string    page frames
2      2      -1  -1
4      2      4   -1
5      2      4   5
4
6      6      4   5
7      6      7   5
5
9      6      7   9
Page Fault Is 6
```





## b) LRU

```
#include<stdio.h>
int i,j,nof,nor,flag=0,ref[50],frm[50],pf=0,victim=-1;
int recent[10],lrucal[50],count=0;
int lruvictim();
void main()
{
    printf("\n\t\t\t LRU PAGE REPLACEMENT ALGORITHM");
    printf("\n Enter no.of Frames....");
    scanf("%d",&nof);
    printf(" Enter no.of reference string..");
    scanf("%d",&nor);
    printf("\n Enter reference string..");
    for(i=0;i<nor;i++)
        scanf("%d",&ref[i]);
    printf("\n\n\t\t LRU PAGE REPLACEMENT ALGORITHM ");
    printf("\n\t The given reference string:");
    printf("\n.....");
    for(i=0;i<nor;i++)
        printf("%4d",ref[i]);
    for(i=1;i<=nof;i++)
    {
        frm[i]=-1;
        lrucal[i]=0;
    } for(i=0;i<10;i++)
        recent[i]=0;
    printf("\n");
    for(i=0;i<nor;i++)
    {
        flag=0;

        printf("\n\t Reference NO %d->\t",ref[i]);

        for(j=0;j<nof;j++)
        {
            if(frm[j]==ref[i])
            {
                flag=1;
                break;
            }
        }
        if(flag==0)
        {
            count++;
            if(count<=nof)
                victim++;
            else
                victim=lruvictim();
            pf++;
            frm[victim]=ref[i];
            for(j=0;j<nof;j++)
                printf("%4d",frm[j]);
        }
        recent[ref[i]]=i;
    }
}
```

```

printf("\n\n\t No.of page faults...%d",pf);
}
int lruvictim()
{
    int i,j,temp1,temp2;
    for(i=0;i<nof;i++)
    {
        temp1=frm[i];
        lrucal[i]=recent[temp1];
    }
    temp2=lrucal[0];
    for(j=1;j<nof;j++)
    {
        if(temp2>lrucal[j])
            temp2=lrucal[j];
    }
    for(i=0;i<nof;i++)
        if(ref[temp2]==frm[i])
            return i;
    return 0;
}

```

## Output:

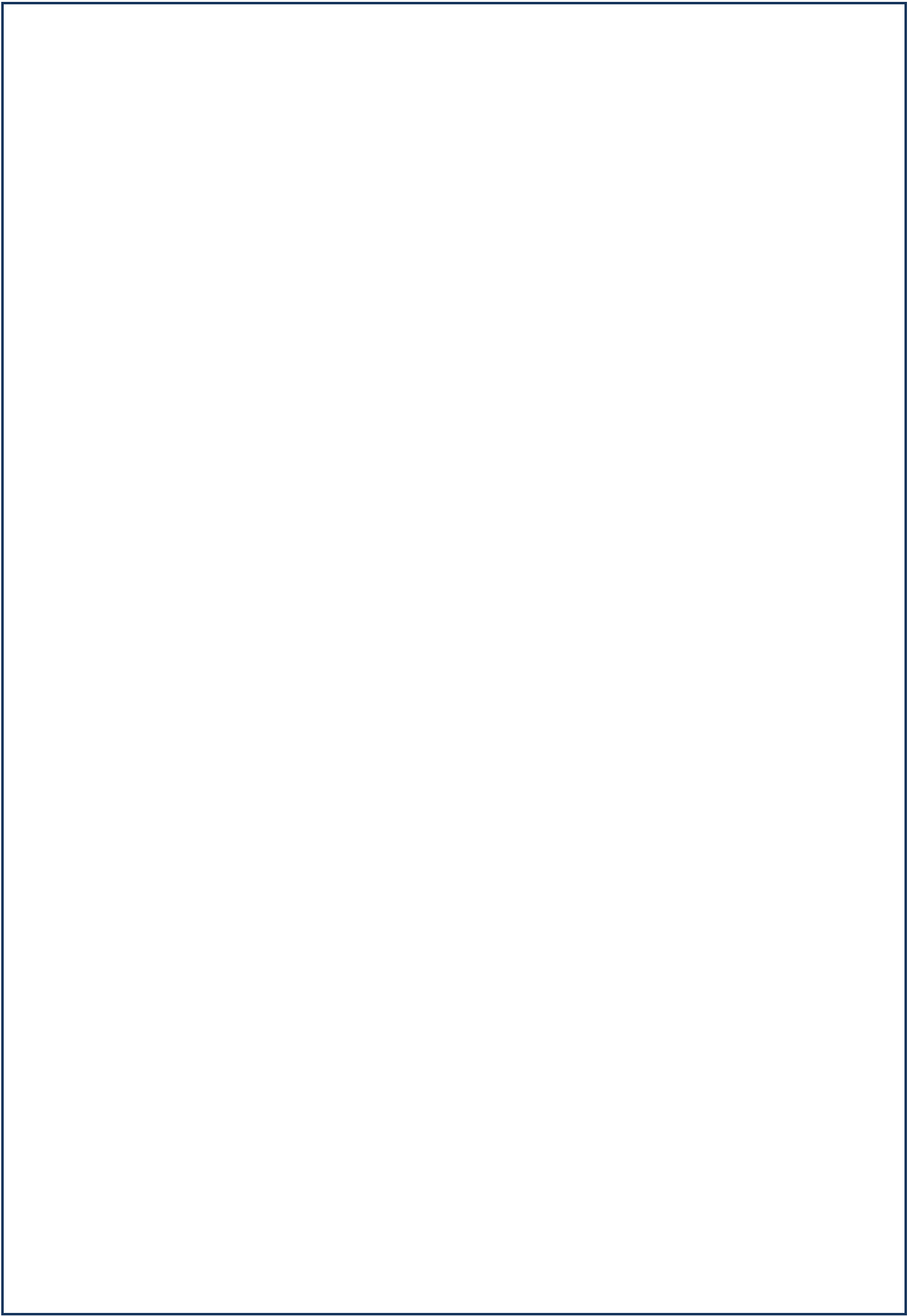
```

LRU PAGE REPLACEMENT ALGORITHM
Enter no.of Frames....3
Enter no.of reference string..8
Enter reference string..
5
6
4
8
2
5
7
6
3
LRU PAGE REPLACEMENT ALGORITHM
The given reference string:
..... 5 6 4 8 2 7 6 3

Reference NO 5->      5  -1  -1
Reference NO 6->      5   6  -1
Reference NO 4->      5   6   4
Reference NO 8->      8   6   4
Reference NO 2->      8   2   4
Reference NO 7->      8   2   7
Reference NO 6->      6   2   7
Reference NO 3->      6   3   7

No.of page faults...8

```



## Program-8

### **Simulate following File Organization Techniques**

#### **a) Single level directory**

```
#include<stdlib.h>
#include<string.h>
#include<stdio.h>
struct
{
    char dname[10],fname[10][10];
    int fcnt;
}dir;
void main()
{
    int i,ch;
    char f[30];
    dir.fcnt = 0;
    printf("\nEnter name of directory -- ");
    scanf("%s", dir.dname);
    while(1)
    {
        printf("\n\n1. Create File\t2. Delete File\t3. Search File \n 4. Display Files\t5. Exit\nEnter your
        choice -- ");
        scanf("%d",&ch);
        switch(ch)
        {
            case 1: printf("\nEnter the name of the file -- ");
                    scanf("%s",dir.fname[dir.fcnt]);
                    dir.fcnt++;
                    break;
            case 2: printf("\nEnter the name of the file -- ");
                    scanf("%s",f);
                    for(i=0;i<dir.fcnt;i++)
                    {
                        if(strcmp(f, dir.fname[i])==0)
                        {
                            printf("File %s is deleted ",f);
                            strcpy(dir.fname[i],dir.fname[dir.fcnt-1]);
                            break;
                        }
                    }
                    if(i==dir.fcnt) printf("File %s not found",f);
                    else
                    dir.fcnt--;
                    break;
            case 3: printf("\nEnter the name of the file -- ");
                    scanf("%s",f);
                    for(i=0;i<dir.fcnt;i++)
                    {
                        if(strcmp(f, dir.fname[i])==0)
                        {
                            printf("File %s is found ", f);
                            break;
                        }
                    }
                }
```

```

        if(i==dir.fcnt)
        printf("File %s not found",f);
        break;
    case 4: if(dir.fcnt==0)
        printf("\nDirectory Empty");
        else
        {
            printf("\nThe Files are -- ");
            for(i=0;i<dir.fcnt;i++)
                printf("\t%s",dir.fname[i]);
        }
        break;
    default: exit(0);
}
}
}

```

### Output:

```

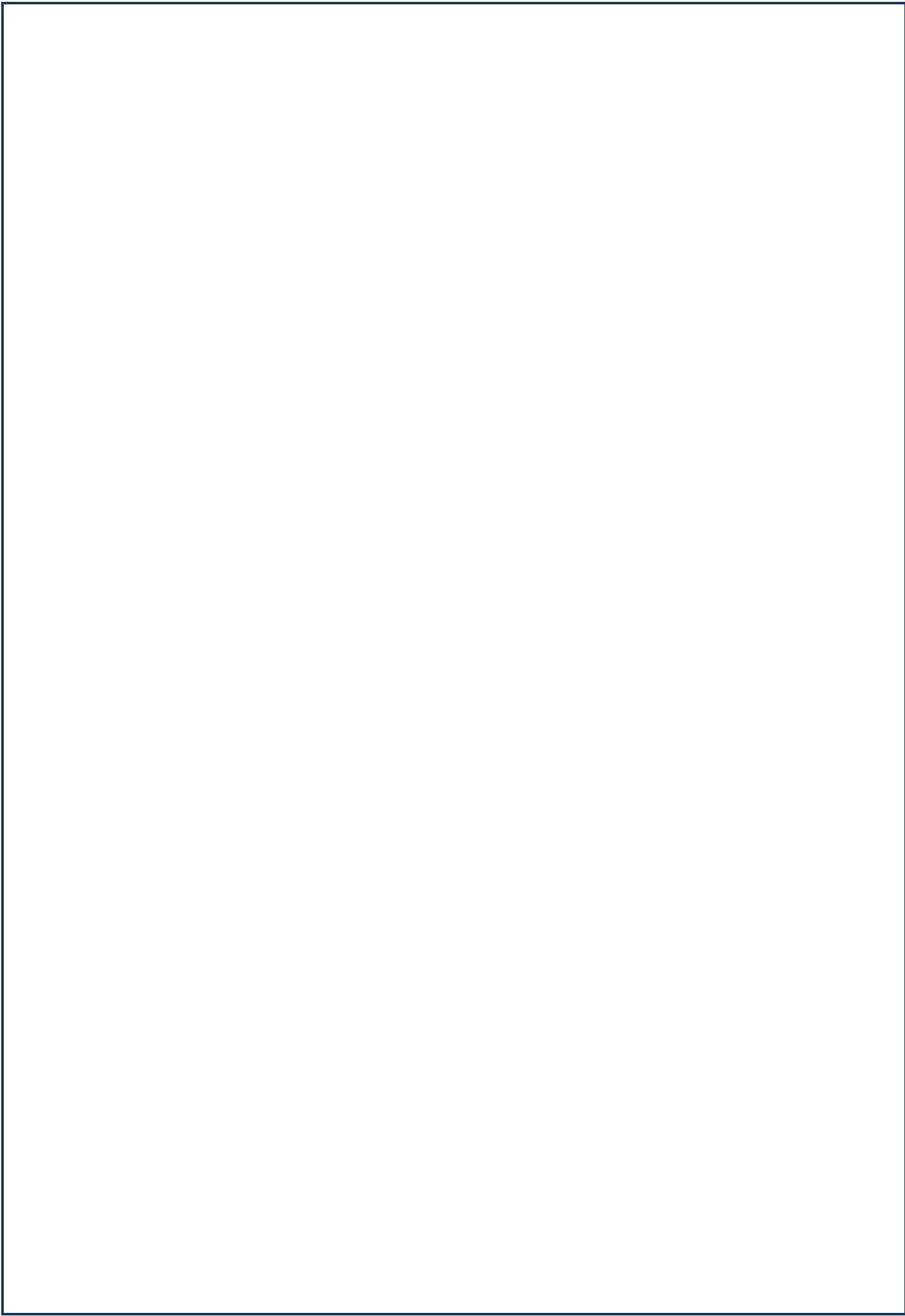
Enter name of directory -- AI
1. Create File  2. Delete File  3. Search File
4. Display Files  5. Exit
Enter your choice -- 1
Enter the name of the file -- ab
1. Create File  2. Delete File  3. Search File
4. Display Files  5. Exit
Enter your choice -- 1
Enter the name of the file -- ac
1. Create File  2. Delete File  3. Search File
4. Display Files  5. Exit
Enter your choice -- 4
The Files are --      ab  ac

1. Create File  2. Delete File  3. Search File
4. Display Files  5. Exit
Enter your choice -- 2
Enter the name of the file -- ab
File ab is deleted

1. Create File  2. Delete File  3. Search File
4. Display Files  5. Exit
Enter your choice -- 4
The Files are --      ac

1. Create File  2. Delete File  3. Search File
4. Display Files  5. Exit
Enter your choice --

```



## b) Two-Level Directory

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

struct
{
    char dname[10],fname[10][10];
    int fcnt;
}dir[10];
void main()
{
    int i,ch,dcnt,k;
    char f[30], d[30];
    dcnt=0;
    while(1)
    {
        printf("\n\n1. Create Directory\t2. Create File\t3. Delete File");
        printf("\n4. Search File\t5. Display\t6. Exit\tEnter your choice -- ");
        scanf("%d",&ch);
        switch(ch)
        {
            case 1: printf("\nEnter name of directory -- ");
                     scanf("%s", dir[dcnt].dname);
                     dir[dcnt].fcnt=0;
                     dcnt++;
                     printf("Directory created");
                     break;
            case 2: printf("\nEnter name of the directory -- ");
                     scanf("%s",d);
                     for(i=0;i<dcnt;i++)
                         if(strcmp(d,dir[i].dname)==0)
                         {
                             printf("Enter name of the file -- ");
                             scanf("%s",dir[i].fname[dir[i].fcnt]);
                             printf("File created");
                             break;
                         }
                     if(i==dcnt)
                         printf("Directory %s not found",d);
                     break;
            case 3: printf("\nEnter name of the directory -- ");
                     scanf("%s",d);
                     for(i=0;i<dcnt;i++)
                     {
                         if(strcmp(d,dir[i].dname)==0)
                         {
                             printf("Enter name of the file -- ");
                             scanf("%s",f);
                             for(k=0;k<dir[i].fcnt;k++)
                             {
                                 if(strcmp(f, dir[i].fname[k])==0)
                                 {
                                     printf("File %s is deleted ",f);
                                     dir[i].fcnt--;
                                 }
                             }
                         }
                     }
        }
    }
}
```



```

        strcpy(dir[i].fname[k],dir[i].fname[dir[i].fcnt]);
        goto jmp;
    }
}
printf("File %s not found",f);
goto jmp;
}
}
printf("Directory %s not found",d);
jmp : break;
case 4: printf("\nEnter name of the directory -- ");
        scanf("%s",d);
        for(i=0;i<dcnt;i++)
        {
            if(strcmp(d,dir[i].dname)==0)
            {
                printf("Enter the name of the file -- ");
                scanf("%s",f);
                for(k=0;k<dir[i].fcnt;k++)
                {
                    if(strcmp(f, dir[i].fname[k])==0)
                    {
                        printf("File %s is found ",f);
                        goto jmp1;
                    }
                }
                printf("File %s not found",f);
                goto jmp1;
            }
        }
        printf("Directory %s not found",d);
        jmp1: break;
case 5: if(dcnt==0)
        printf("\nNo Directory's ");
        else
        {
            printf("\nDirectory\tFiles");
            for(i=0;i<dcnt;i++)
            {
                printf("\n% s\t\t",dir[i].dname);
                for(k=0;k<dir[i].fcnt;k++)
                printf("\t%s",dir[i].fname[k]);
            }
        }
        break;
default:exit(0);
}
}
}

```

## Output:

```
1. Create Directory 2. Create File 3. Delete File
4. Search File      5. Display 6. Exit Enter your choice -- 1
Enter name of directory -- abc
Directory created
```

```
1. Create Directory 2. Create File 3. Delete File
4. Search File      5. Display 6. Exit Enter your choice -- 1
Enter name of directory -- xyz
Directory created
```

```
1. Create Directory 2. Create File 3. Delete File
4. Search File      5. Display 6. Exit Enter your choice -- 2
Enter name of the directory -- xyz
Enter name of the file -- aa
File created
```

```
1. Create Directory 2. Create File 3. Delete File
4. Search File      5. Display 6. Exit Enter your choice -- 5
Directory   Files
abc
xyz
```

```
1. Create Directory 2. Create File 3. Delete File
4. Search File      5. Display 6. Exit Enter your choice -- |
```

### Program-9

**Develop a C program to simulate the Linked file allocation strategies.**

```
#include<stdio.h>
#include<conio.h>
#include<stdlib.h>
void main()
{
    int f[50], p,i, st, len, j, c, k, a;
    clrscr();
    for(i=0;i<50;i++)
        f[i]=0;
    printf("Enter how many blocks already allocated: ");
    scanf("%d",&p);
    printf("Enter blocks already allocated: ");
    for(i=0;i<p;i++)
    {
        scanf("%d",&a);
        f[a]=1;
    }

    x: printf("Enter index starting block and length: ");
    scanf("%d%d", &st,&len);
    k=len;
    if(f[st]==0)
    {
        for(j=st;j<(st+k);j++)
        {
            if(f[j]==0)
            {
                f[j]=1;
                printf("%d----->%d\n",j,f[j]);
            }
            else
            {
                printf("%d Block is already allocated \n",j);
                k++;
            }
        }
    }
    else
        printf("%d starting block is already allocated \n",st);
    printf("Do you want to enter more file(Yes - 1/No - 0)");
    scanf("%d", &c);
    if(c==1)
        goto x;
    else
        exit(0);
    getch();
}
```

### Output:

```
Enter how many blocks already allocated: 3
Enter blocks already allocated: 1 3 5
Enter index starting block and length: 2 2
2----->1
3 Block is already allocated
4----->1
Do you want to enter more file(Yes - 1/No - 0)
```

---

## Program-10

**Develop a C program to simulate SCAN disk scheduling algorithm.**

```
#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 :\n");
    scanf("%d", &SIZE);
    printf("ENTER THE NO OF REQUEST SEQUENCE :\n");
    scanf("%d", &n);
    printf("ENTER THE REQUEST SEQUENCE :\n");
    for (i = 0; i < n; i++)
        scanf("%d", &request[i]);
    printf("ENTER THE CURRENT HEAD :\n");
    scanf("%d", &head);
    request[n] = head;
    request[n + 1] = SIZE - 1;
    request[n + 2] = 0;
    printf("ENTER THE PRE REQUEST :\n");
    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

```

