

OPERATING SYSTEMS

LAB MANUAL

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INFORMATION TECHNOLOGY

Program Outcomes	
PO1	Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2	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.
PO3	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.
PO4	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.
PO5	Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6	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.
PO7	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.
PO8	Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9	Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10	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.
PO11	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.
PO12	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.
Program Specific Outcomes	
PSO1	Professional Skills: The ability to research, understand and implement computer programs in the areas related to algorithms, system software, multimedia, web design, big data analytics, and networking for efficient analysis and design of computer-based systems of varying complexity.
PSO2	Software Engineering Practices: The ability to apply standard practices and strategies in software project development using open-ended programming environments to deliver a quality product for business success.
PSO3	Successful Career and Entrepreneurship: The ability to employ modern computer languages, environments, and platforms in creating innovative career paths, to be an entrepreneur, and a zest for higher studies.

OPERATING SYSTEMS LAB SYLLABUS

(Practical Hours: 03, Credits: 02)

Implement the following programs on Linux platform using C language.

Exp. No.	Division of Experiments	List of Experiments	Page No.
1	CPU Scheduling Algorithms	Write a C program to simulate the following non-preemptive CPU Scheduling algorithms to find turnaround time and waiting time. a)FCFS b) SJF	
2	CPU Scheduling Algorithms	Write a C program to simulate the following non-preemptive CPU Scheduling algorithms to find turnaround time and waiting time. a) Round Robin b) Priority	
3	File Allocation Strategies	Write a C program to simulate the following file allocation strategies. a) Sequential b) Indexed c) Linked	
4	Memory Management Techniques	Write a C program to simulate the MVT and MFT memory management techniques.	
5	File Organization Techniques	Write a C program to simulate the following file organization techniques a) Single level directory b) Two level directory	
6	File Organization Techniques	Write a C program to simulate the following file organization techniques a) Hierarchical b) DAG	
7	Banker Algorithms	Write a C program to simulate Bankers algorithm for the purpose of deadlock avoidance	
8	Banker Algorithms	Write a C program to simulate Bankers algorithm for the purpose of deadlock Prevention	
9	Page Replacement Algorithms	Write a C program to simulate page replacement algorithms FIFO	
10	Page Replacement Algorithms	Write a C program to simulate page replacement algorithms LRU	
11	Page Replacement Algorithms	Write a C program to simulate page replacement algorithms LFU	
12	Paging Techniques	Simulate paging technique of memory management	
	Lab Questions & Assignments		

ATTAINMENT OF PROGRAM OUTCOMES & PROGRAM SPECIFIC OUTCOMES

Exp. No.	Experiment	Program Outcomes Attained	Program Specific Outcomes Attained
1	Write a C program to simulate the following non-preemptive CPU scheduling algorithms to find turnaround time and waiting time. a) FCFS b) SJF	PO1, PO2, PO4	PSO1
2	Write a C program to simulate the following non-preemptive CPU scheduling algorithms to find turnaround time and waiting time. a) Round Robin b) Priority	PO1, PO2, PO4	PSO1
3	Write a C program to simulate the following file allocation strategies. a) Sequential b) Indexed c) Linked	PO1, PO2, PO4	PSO1
4	Write a C program to simulate the MVT and MFT memory management techniques.	PO1, PO2, PO4	PSO1
5	Write a C program to simulate the following file organization techniques a) Single level directory b) Two level directory	PO1, PO2, PO4	PSO1
6	Write a C program to simulate the following file organization techniques a) Hierarchical b) DAG	PO1, PO2, PO4	PSO1
7	Write a C program to simulate Bankers algorithm for the purpose of deadlock avoidance.	PO1, PO2, PO4	PSO1
8	Write a C program to simulate Bankers algorithm for the purpose of deadlock Prevention.	PO1, PO2, PO4	PSO1
9	Write a C program to simulate page replacement algorithms a) FIFO b) c) LFU	PO1, PO2	PSO1
10	Write a C program to simulate page replacement algorithms LRU	PO1, PO2	PSO1
11	Write a C program to simulate page replacement algorithms LFU	PO1, PO2	PSO1
12	Write a C program to simulate paging technique of memory management.	PO1, PO2, PO4	PSO1

OPERATING SYSTEMS LABORATORY

OBJECTIVE:

This lab complements the operating systems course. Students will gain practical experience with designing and implementing concepts of operating systems such as system calls, CPU scheduling, process management, memory management, file systems and deadlock handling using C language in Linux environment.

OUTCOMES:

Upon the completion of Operating Systems practical course, the student will be able to:

1. **Understand** and implement basic services and functionalities of the operating system using system calls.
2. **Use** modern operating system calls and synchronization libraries in software/hardware interfaces.
3. **Understand** the benefits of thread over process and implement synchronized programs using multithreading concepts.
4. **Analyze** and simulate CPU Scheduling Algorithms like FCFS, Round Robin, SJF, and Priority.
5. **Implement** memory management schemes and page replacement schemes.
6. **Simulate** file allocation and organization techniques.
7. **Understand** the concepts of deadlock in operating systems and implement them in multiprogramming system.

INPUT

```
Enter the number of processes -- 3
Enter Burst Time for Process 0 -- 24
Enter Burst Time for Process 1 -- 3
Enter Burst Time for Process 2 -- 3
```

OUTPUT

PROCESS	BURST TIME	WAITING TIME	TURNAROUND TIME
P0	24	0	24
P1	3	24	27
P2	3	27	30

Average Waiting Time -- 17.000000

Average Turnaround Time -- 27.000000

SJF CPU SCHEDULING ALGORITHM

```
#include<stdio.h>
#include<conio.h>
main()
{
    int p[20], bt[20], wt[20], tat[20], i, k, n, temp;
    float wtavg, tatavg;
    clrscr();
    printf("\nEnter the number of processes -- ");
    scanf("%d", &n);
    for(i=0; i<n; i++)
    {
        p[i]=i;
        printf("Enter Burst Time for Process %d -- ", i);
        scanf("%d", &bt[i]);
    }
    for(i=0; i<n; i++)
        for(k=i+1; k<n; k++)
            if(bt[i]>bt[k])
            {
                temp=bt[i];
                bt[i]=bt[k];
                bt[k]=temp;

                temp=p[i];
                p[i]=p[k];
                p[k]=temp;
            }
    wt[0] = wtavg = 0;
    tat[0] = tatavg = bt[0];
    for(i=1; i<n; i++)
    {
        wt[i] = wt[i-1] + bt[i-1];
        tat[i] = tat[i-1] + bt[i];
        wtavg = wtavg + wt[i];
        tatavg = tatavg + tat[i];
    }
    printf("\n\t PROCESS \t BURST TIME \t WAITING TIME \t TURNAROUND TIME\n");
    for(i=0; i<n; i++)
```

```

printf("\n\t P%d \t\t %d \t\t %d \t\t %d", p[i], bt[i], wt[i], tat[i]);
printf("\nAverage Waiting Time -- %f", wtavg/n);
printf("\nAverage Turnaround Time -- %f", tatavg/n);
getch();
}

```

INPUT

```

Enter the number of processes --      4
Enter Burst Time for Process 0 --    6
Enter Burst Time for Process 1 --    8
Enter Burst Time for Process 2 --    7
Enter Burst Time for Process 3 --    3

```

OUTPUT

PROCESS	BURST TIME	WAITING TIME	TURNAROUND TIME
P3	3	0	3
P0	6	3	9
P2	7	9	16
P1	8	16	24
Average Waiting Time --	7.000000		
Average Turnaround Time --	13.000000		

EXPERIMENT 2

OBJECTIVE

Write a C program to simulate the following non-preemptive CPU scheduling algorithms to find turnaround time and waiting time for the above problem.

a) Round Robin b) Priority

ROUND ROBIN CPU SCHEDULING ALGORITHM

For round robin scheduling algorithm, read the number of processes/jobs in the system, their CPU burst times, and the size of the time slice. Time slices are assigned to each process in equal portions and in circular order, handling all processes execution. This allows every process to get an equal chance. Calculate the waiting time and turnaround time of each of the processes accordingly.

PRIORITY CPU SCHEDULING ALGORITHM

For priority scheduling algorithm, read the number of processes/jobs in the system, their CPU burst times, and the priorities. Arrange all the jobs in order with respect to their priorities. There may be two jobs in queue with the same priority, and then FCFS approach is to be performed. Each process will be executed according to its priority. Calculate the waiting time and turnaround time of each of the processes accordingly.

ROUND ROBIN CPU SCHEDULING ALGORITHM

```
#include<stdio.h>
main()
{
    int i,j,n,bu[10],wa[10],tat[10],t,ct[10],max; float
    awt=0,att=0,temp=0;
    clrscr();
    printf("Enter the no of processes -- ");
    scanf("%d",&n);

    for(i=0;i<n;i++)
    {
        printf("\nEnter Burst Time for process %d -- ", i+1); scanf("%d",&bu[i]);
        ct[i]=bu[i];
    }
    printf("\nEnter the size of time slice -- ");
    scanf("%d",&t);
    max=bu[0];
    for(i=1;i<n;i++)
        if(max<bu[i])
            max=bu[i];
    for(j=0;j<(max/t)+1;j++)
        for(i=0;i<n;i++)
            if(bu[i]!=0)
                if(bu[i]<=t)
                {
                    tat[i]=temp+bu[i];
                    temp=temp+bu[i];
                    bu[i]=0;
                }
                else
                {
                    bu[i]=bu[i]-t;
                    temp=temp+t;
                }

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

```

        wa[i]=tat[i]-
        ct[i]; att+=tat[i];
        awt+=wa[i];
    }
    printf("\n\nThe Average Turnaround time is -- %f",att/n);
    printf("\n\nThe Average Waiting time is -- %f ",awt/n);
    printf("\n\n\tPROCESS\t BURST TIME \t WAITING TIME\tTURNAROUND TIME\n");
    for(i=0;i<n;i++)
        printf("\t%d \t %d \t\t %d \t\t %d \n",i+1,ct[i],wa[i],tat[i]);
    getch();
}

```

INPUT

```

Enter the no of processes – 3
Enter Burst Time for process 1 –      24
Enter Burst Time for process 2 --     3
Enter Burst Time for process 3 --     3

```

Enter the size of time slice – 3

OUTPUT

```

The Average Turnaround time is – 15.666667 The
Average Waiting time is --      5.666667

```

PROCESS	BURST TIME	WAITING TIME	TURNAROUND TIME
1	24	6	30
2	3	4	7
3	3	7	10

PRIORITY CPU SCHEDULING ALGORITHM

```

#include<stdio.h>
main()
{
    int p[20],bt[20],pri[20], wt[20],tat[20],i, k,n, temp;
    float wtavg, tatavg;
    clrscr();
    printf("Enter the number of processes --- ");
    scanf("%d",&n);

    for(i=0;i<n;i++)
    {
        p[i] = i;
        printf("Enter the Burst Time & Priority of Process %d --- ",i);
        scanf("%d %d",&bt[i], &pri[i]);
    }
    for(i=0;i<n;i++)
        for(k=i+1;k<n;k++)
            if(pri[i] > pri[k])
            {
                temp=p[i];
                p[i]=p[k];
                p[k]=temp;

                temp=bt[i];
                bt[i]=bt[k];
                bt[k]=temp;

                temp=pri[i];
                pri[i]=pri[k];
                ;
                pri[k]=temp;
            }
}

```

```

    }
    wtavg = wt[0] = 0;
    tatavg = tat[0] = bt[0];
    for(i=1;i<n;i++)
    {
        wt[i] = wt[i-1] + bt[i-1];
        tat[i] = tat[i-1] + bt[i];

        wtavg = wtavg + wt[i];
        tatavg = tatavg + tat[i];
    }

    printf("\nPROCESS\t\tPRIORITY\tBURST TIME\tWAITING TIME\tTURNAROUND TIME");
    for(i=0;i<n;i++)
        printf("\n%d \t\t %d \t\t %d \t\t %d \t\t %d ",p[i],pri[i],bt[i],wt[i],tat[i]);

    printf("\nAverage Waiting Time is --- %f",wtavg/n);
    printf("\nAverage Turnaround Time is --- %f",tatavg/n);
    getch();
}

```

INPUT

```

Enter the number of processes --      5
Enter the Burst Time & Priority of Process 0 --- 10      3
Enter the Burst Time & Priority of Process 1 --- 1      1
Enter the Burst Time & Priority of Process 2 --- 2      4
Enter the Burst Time & Priority of Process 3 --- 1      5
Enter the Burst Time & Priority of Process 4 --- 5      2

```

OUTPUT

PROCESS	PRIORITY	BURST TIME	WAITING TIME	TURNAROUND TIME
1	1	1	0	1
4	2	5	1	6
0	3	10	6	16
2	4	2	16	18
3	5	1	18	19

Average Waiting Time is --- 8.200000

Average Turnaround Time is --- 12.000000

EXPERIMENT 3

OBJECTIVE

Write a C program to simulate the following file allocation strategies.

a) Sequential b) Linked c)) Indexed

DESCRIPTION

A file is a collection of data, usually stored on disk. As a logical entity, a file enables to divide data into meaningful groups. As a physical entity, a file should be considered in terms of its organization. The term "file organization" refers to the way in which data is stored in a file and, consequently, the method(s) by which it can be accessed.

SEQUENTIAL FILE ALLOCATION

In this file organization, the records of the file are stored one after another both physically and logically. That is, record with sequence number 16 is located just after the 15th record. A record of a sequential file can only be accessed by reading all the previous records.

LINKED FILE ALLOCATION

With linked allocation, each file is a linked list of disk blocks; the disk blocks may be scattered anywhere on the disk. The directory contains a pointer to the first and last blocks of the file. Each block contains a pointer to the next block.

INDEXED FILE ALLOCATION

Indexed file allocation strategy brings all the pointers together into one location: an index block. Each file has its own index block, which is an array of disk-block addresses. The i^{th} entry in the index block points to the i^{th} block of the file. The directory contains the address of the index block. To find and read the i^{th} block, the pointer in the i^{th} index-block entry is used.

PROGRAM

SEQUENTIAL FILE ALLOCATION

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

struct fileTable
{
    char name[20]; int
    sb, nob;
}ft[30]
;

void main()
{
    int i, j, n;
    char s[20];
    clrscr();
    printf("Enter no of files
    :")
    ; scanf("%d",&n);

    for(i=0;i<n;i++)
    {
        printf("\nEnter file name %d
        :",i+1);
        scanf("%s",ft[i].name);
        printf("Enter starting block of file %d
        :",i+1);
        scanf("%d",&ft[i].sb);
        printf("Enternoofblocks in file %d:",i+1);
        scanf("%d",&ft[i].nob);
    }
    printf("\nEnter the filename to be searched--");
    scanf("%s",s);
    for(i=0;i<n;i++)
        if(strcmp(s, ft[i].name)==0)
```

```

                break;
        if(i==n)
            printf("\nFile Not Found");
        else
        {
            printf("\nFILE NAME START BLOCK NO OF BLOCKS BLOCKS OCCUPIED\n");
            printf("\n%s\t\t%d\t\t%d\t",ft[i].name,ft[i].sb,ft[i].nob); for(j=0;j<ft[i].nob;j++)
                printf("%d, ",ft[i].sb+j);
        }
        getch();
    }
}

```

INPUT:

Enter no of files :3

Enter file name 1 :A

Enter starting block of file 1 :85

Enter no of blocks in file 1 :6

Enter file name 2 :B

Enter starting block of file 2 :102

Enter no of blocks in file 2 :4

Enter file name 3 :C

Enter starting block of file 3 :60

Enter no of blocks in file 3 :4

Enter the file name to be searched -- B

OUTPUT:

FILENAME	STARTBLOCK	NO OF BLOCKS	BLOCKS OCCUPIED
B	102	4	102, 103, 104, 105

LINKED FILE ALLOCATION

```

#include<stdio.h>
#include<conio.h>

```

```

struct fileTable
{
    char name[20];
    int nob;
    struct block *sb;
}ft[30];

struct block
{
    int bno;
    struct block *next;
};

```

```

void main()
{
    int i, j, n;
    char s[20];
    struct block *temp;
    clrscr();
    printf("Enter no of files\n");
    scanf("%d",&n);
    for(i=0;i<n;i++)
    {
        printf("\nEnter file name\n");
        scanf("%s",ft[i].name);
    }
}

```

```

printf("Enternoofblocks in file %d:",i+1);
scanf("%d",&ft[i].nob);
ft[i].sb=(struct block*)malloc(sizeof(struct block));
temp = ft[i].sb;
printf("Enter the blocks of the file:");
scanf("%d",&temp->bno);
temp->next=NULL;

for(j=1;j<ft[i].nob;j++)
{
    temp->next = (struct block*)malloc(sizeof(struct block));
    temp = temp->next;
    scanf("%d",&temp->bno);
}
temp->next = NULL;
}
printf("\nEnter the file name to be searched --");
scanf("%s",s);
for(i=0;i<n;i++)
    if(strcmp(s, ft[i].name)==0)
        break;
if(i==n)
    printf("\nFile Not Found");
else
{
    printf("\nFILE NAME NO OF BLOCKS BLOCKS OCCUPIED");
    printf("\n %s\t\t%d\t",ft[i].name,ft[i].nob);
    temp=ft[i].sb;
    for(j=0;j<ft[i].nob;j++)
    {
        printf("%d □ ",temp->bno); temp
        = temp->next;
    }
}
getch();
}

```

INPUT:

Enter noof files 2

Enter file 1 : A

Enter no of blocks in file 1 4

Enter the blocks of the file 1 : 12 23 9 4

Enter file 2 : G

Enter no of blocks in file 2 5

Enter the blocks of the file 2 : 88 77 66 55 44

Enter the file to be searched : G

OUTPUT:

FILENAME	NO OF BLOCKS	BLOCKS OCCUPIED
G	5	88 □ 77 □ 66 □ 55 □ 44

INDEXED FILE ALLOCATION

```

#include<stdio.h>
#include<conio.h>

struct fileTable
{
    char name[20];
    int nob, blocks[30];
}

```

```

}ft[30];

void main()
{
    int i, j, n;
    char s[20];
    clrscr();
    printf("Enter no of files
           :")

    ; scanf("%d",&n);
    for(i=0;i<n;i++)
    {
        printf("\nEnter file name %d
               :",i+1);
        scanf("%s",ft[i].name);
        printf("Enternoofblocks in file %d:",i+1);
        scanf("%d",&ft[i].nob);
        printf("Enter the blocks of the file:");
        for(j=0;j<ft[i].nob;j++)
            scanf("%d",&ft[i].blocks[j]);
    }

    printf("\nEnter the filename to be searched --");
    scanf("%s",s);
    for(i=0;i<n;i++)
        if(strcmp(s, ft[i].name)==0)
            break;
    if(i==n)
        printf("\nFile Not Found");
    else
    {
        printf("\nFILE NAME NO OF BLOCKS BLOCKS OCCUPIED");
        printf("\n %s\t\t%d\t",ft[i].name,ft[i].nob);
        for(j=0;j<ft[i].nob;j++)
            printf("%d, ",ft[i].blocks[j]);
    }
    getch();
}

```

INPUT:

```

Enter no of files      2

Enter file 1 : A
Enter no of blocks in file 1      4
Enter the blocks of the file 1      : 12 23 9 4

Enter file 2 : G
Enter no of blocks in file 2      5
Enter the blocks of the file 2      : 88 77 66 55 44
Enter the file to be searched : G

```

OUTPUT:

FILENAME	NO OF BLOCKS	BLOCKS OCCUPIED
G	5	88, 77, 66, 55, 44

EXPERIMENT 4

OBJECTIVE

Write a C program to simulate the MVT and MFT memory management techniques

DESCRIPTION

MFT (Multiprogramming with a Fixed number of Tasks) is one of the old memory management techniques in which the memory is partitioned into fixed size partitions and each job is assigned to a partition. The memory assigned to a partition does not change. MVT (Multiprogramming with a Variable number of Tasks) is the memory management technique in which each job gets just the amount of memory it needs. That is, the partitioning of memory is dynamic and changes as jobs enter and leave the system. MVT is a more "efficient" user of resources. MFT suffers with the problem of internal fragmentation and MVT suffers with external fragmentation.

PROGRAM

MFT MEMORY MANAGEMENT TECHNIQUE

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

main()
{
    intms,bs,nob,ef,n,mp[10],tif=0;
    int i,p=0;

    clrscr();
    printf("Enterthetotalmemoryavailable(inBytes)--");
    scanf("%d",&ms);
    printf("Entertheblocksize(inBytes)--");
    scanf("%d",&bs);
    nob=ms/bs;
    ef=ms -nob*bs;
    printf("\nEnterthenumberofprocesses--");
    scanf("%d",&n);
    for(i=0;i<n;i++)
    {
        printf("Enter memory required for process %d (in Bytes)-- ",i+1);
        scanf("%d",&mp[i]);
    }

    printf("\nNo. of Blocks available in memory -- %d",nob);
    printf("\n\nPROCESS\tMEMORY REQUIRED\tALLOCATED\tINTERNAL FRAGMENTATION");
    for(i=0;i<n && p<nob;i++)
    {
        printf("\n %d\t\t%d",i+1,mp[i]);
        if(mp[i] > bs)
            printf("\t\tNO\t\t---");
        else
        {
            printf("\t\tYES\t\t%d",bs-mp[i]);
            tif = tif + bs-mp[i];
            p++;
        }
    }
    if(i<n)
        printf("\nMemory is Full, Remaining Processes cannot be accomodated");

    printf("\n\nTotal Internal Fragmentation is %d",tif);
    printf("\nTotal External Fragmentation is %d",ef);
    getch();
}
```


}

INPUT

Enter the total memory available (in Bytes)-- 1000
Enter the block size (in Bytes)-- 300
Enter the number of processes 5
Enter memory required for process 1 (in Bytes)-- 275
Enter memory required for process 2 (in Bytes)-- 400
Enter memory required for process 3 (in Bytes)-- 290
Enter memory required for process 4 (in Bytes)-- 293
Enter memory required for process 5 (in Bytes)-- 100

No. of Blocks available in memory-- 3

OUTPUT

PROCESS	MEMORY REQUIRED	ALLOCATED	INTERNAL FRAGMENTATION
1	275	YES	25
2	400	NO	-----
3	290	YES	10
4	293	YES	7

Memory is Full, Remaining Processes cannot be accommodated Total

Internal Fragmentation is 42

Total External Fragmentation is 100

MVT MEMORY MANAGEMENT TECHNIQUE

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

```
#include<conio.h>
```

```
main()
```

```
{
```

```
int ms,mp[10],i, temp,n=0; char
```

```
ch = 'y';
```

```
clrscr();
```

```
printf("\nEnter the total memory available (in Bytes)-- ");
```

```
scanf("%d",&ms);
```

```
temp=ms;
```

```
for(i=0;ch=='y';i++,n++)
```

```
{
```

```
printf("\nEnter memory required for process %d (in Bytes) -- ",i+1);
```

```
scanf("%d",&mp[i]);
```

```
if(mp[i]<=temp)
```

```
{
```

```
printf("\nMemory is allocated for Process %d ",i+1);
```

```
temp = temp - mp[i];
```

```
}
```

```
else
```

```
{
```

```
printf("\nMemory is Full");
```

```
break;
```

```
}
```

```
printf("\nDo you want to continue(y/n) -- ");
```

```
scanf(" %c",&ch);
```

```
}
```

```
printf("\n\nTotal Memory Available -- %d", ms);
```

```
printf("\n\n\tPROCESS\t\tMEMORY ALLOCATED ");
```

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

```
printf("\n \t%d\t\t%d",i+1,mp[i]);
```

```
printf("\n\nTotal Memory Allocated is %d",ms-temp);
```

```
printf("\n\nTotal External Fragmentation is %d",temp);
```

```
getch();  
}
```

INPUT

Enter the total memory available (in Bytes) -- 1000

Enter memory required for process 1 (in Bytes)-- 400

Memory is allocated for Process 1

Do you want to continue(y/n)-- y

Enter memory required for process 2 (in Bytes)-- 275

Memory is allocated for Process 2

Do you want to continue(y/n)-- y

Enter memory required for process 3 (in Bytes)-- 550

OUTPUT

Memory is Full

Total Memory Available -- 1000

PROCESS	MEMORY ALLOCATED
1	400
2	275

Total Memory Allocated is 675

Total External Fragmentation is 325

EXPERIMENT 5

OBJECTIVE

Write a C program to simulate the following file organization techniques
a) Single level directory b) Two level directory

DESCRIPTION

The directory structure is the organization of files into a hierarchy of folders. In a single-level directory system, all the files are placed in one directory. There is a root directory which has all files. It has a simple architecture and there are no sub directories. Advantage of single level directory system is that it is easy to find a file in the directory. In the two-level directory system, each user has own user file directory (UFD). The system maintains a master block that has one entry for each user. This master block contains the addresses of the directory of the users. When a user job starts or a user logs in, the system's master file directory (MFD) is searched. When a user refers to a particular file, only his own UFD is searched. This effectively solves the name collision problem and isolates users from one another. Hierarchical directory structure allows users to create their own subdirectories and to organize their files accordingly. A tree is the most common directory structure. The tree has a root directory, and every file in the system has a unique path name. A directory (or subdirectory) contains a set of files or subdirectories.

PROGRAM

SINGLE LEVEL DIRECTORY ORGANIZATION

```
#include<stdio.h> struct
{
    char dname[10],fname[10][10]; int
    fcnt;
}dir;

void main()
{
    int i,ch; char
    f[30];
    clrscr();
    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);
}

}
getch();
}

```

OUTPUT:

Enter name of directory -- CSE

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

Enter the name of the file -- A

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

Enter the name of the file -- B

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

Enter the name of the file -- C

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

The Files are -- A B C

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

Enter the name of the file -- ABC

File ABC not found

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

Enter the name of the file – B
File B is deleted

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

TWO LEVEL DIRECTORY ORGANIZATION

```
#include<stdio.h> struct
{
    char dname[10],fname[10][10]; int
    fcnt;
}dir[10]
;

void main()
{
    int i,ch,dcnt,k;
    charf[30],d[30];
    clrscr();
    dcnt=0;

    while(1)
    {
        printf("\n\n1. Create Directory\t2. Create File\t3. Delete File"); printf("\n4.
        Search File\t5. Display\t6. Exit\t
        Enter 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]);
                            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;

case4: 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% sis 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);
}

}
getch();
}

```

OUTPUT:

```

1. CreateDirectory      2. CreateFile      3. Delete File
4. SearchFile          5. Display        6. Exit      Enter your choice--      1

```

```

Enter name of directory -- DIR1
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 -- DIR2
 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 -- DIR1
 Enter name of the file -- A1 File
 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 -- DIR1
 Enter name of the file -- A2 File
 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 -- DIR2
 Enter name of the file -- B1 File
 created

1. Create Directory 2. Create File 3. Delete File
 4. Search File 5. Display 6. Exit Enter your choice-- 5
 Directory Files
 DIR1 A1 A2
 DIR2 B1

1. Create Directory 2. Create File 3. Delete File
 4. Search File 5. Display 6. Exit Enter your choice-- 4
 Enter name of the directory -- DIR
 Directory not found

1. Create Directory 2. Create File 3. Delete File
 4. Search File 5. Display 6. Exit Enter your choice-- 3
 Enter name of the directory -- DIR1
 Enter name of the file -- A2
 File A2 is deleted

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

EXPERIMENT 6

OBJECTIVE

Write a C program to simulate the following file organization techniques

a) Hierarchical c) DAG

DESCRIPTION

Hierarchical directory structure allows users to create their own subdirectories and to organize their files accordingly. A tree is the most common directory structure. The tree has a root directory, and every file in the system has a unique path name. A directory (or subdirectory) contains a set of files or subdirectories.

HIERARCHICAL DIRECTORY ORGANIZATION

```
#include<stdio.h>
#include<graphics.h>
struct tree_element
{
    char name[20];
    int x, y, ftype, lx, rx, nc, level;
    struct tree_element *link[5];
};
typedef struct tree_element node; void
main()
{
    int gd=DETECT, gm;
    node *root;
    root=NULL;
    clrscr();
    create(&root, 0, "root", 0, 639, 320); clrscr();
    initgraph(&gd, &gm, "c:\\tc\\BGI");
    display(root);
    getch();
    closegraph();
}
create(node **root, int lev, char *dname, int lx, int rx, int x)
{
    int i, gap;
    if(*root==NULL)
    {
        (*root)=(node *)malloc(sizeof(node));
        printf("Enter name of dir/file(under %s) : ", dname);
        fflush(stdin);
        gets((*root)->name);
        printf("enter 1 for Dir/2 for file :");
        scanf("%d", &(*root)->ftype);
        (*root)->level=lev;
        (*root)->y=50+lev*50;
        (*root)->x=x;
        (*root)->lx=lx;
        (*root)->rx=rx;
        for(i=0; i<5; i++)
            (*root)-
            >link[i]=NULL; if((*root)-
            >ftype==1)
            {
                printf("No of sub directories/files(for %s):", (*root)->name); scanf("%d", &(*root)->nc);
                if((*root)->nc==0)
                    gap=rx-lx;
                else
                    gap=(rx-lx)/(*root)->nc;
            }
    }
}
```



```

        else
            for(i=0;i<(*root)->nc;i++)
        }
        create(&((*root)->link[i]),lev+1,(*root)->name,lx+gap*i,lx+gap*i+gap,
                                                    lx+gap*i+gap/2);
    }

    (*root)->nc=0;

display(node *root)
{
    int i;
    settxtstyle(2,0,4);
    settxtjustify(1,1);
    setfillstyle(1,BLUE);
    setcolor(14);
    if(root !=NULL)
    {
        for(i=0;i<root->nc;i++)
            line(root->x,root->y,root->link[i]->x,root->link[i]->y);
        if(root->ftype==1)
            bar3d(root->x-20,root->y-10,root->x+20,root->y+10,0,0); else
            fillellipse(root->x,root->y,20,20);
        outtextxy(root->x,root->y,root->name);
        for(i=0;i<root->nc;i++)
            display (root->link[i]);
    }
}

```

INPUT

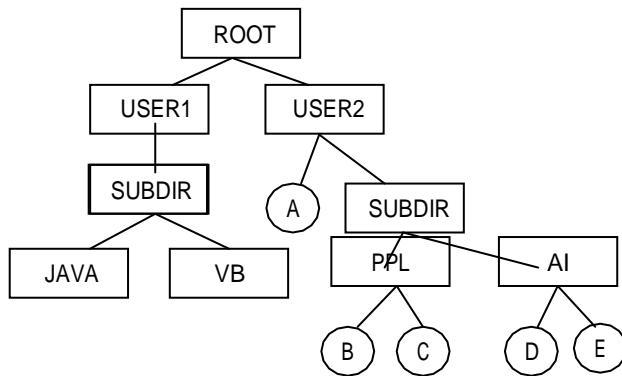
```

Enter Name of dir/file(under root): ROOT
Enter 1 for Dir/2 for File: 1
No of subdirectories/files(for ROOT): 2 Enter
Name of dir/file(under ROOT):USER1 Enter 1 for
Dir/2 for File: 1
No of subdirectories/files(for USER1): 1
Enter Name of dir/file(under USER1): SUBDIR1
Enter 1 for Dir/2 for File: 1
No of subdirectories/files(for SUBDIR1): 2 Enter
Name of dir/file(under USER1):JAVA Enter 1 for
Dir/2 for File: 1
No of subdirectories/files(for JAVA): 0
EnterName of dir/file(underSUBDIR1):VB
Enter 1 for Dir/2 for File: 1
No of subdirectories/files(for VB): 0
Enter Name of dir/file(under ROOT):USER2 Enter
1 for Dir/2 for File: 1
Noofsubdirectories/files(forUSER2):2
Enter Name of dir/file(under ROOT): A
Enter 1 for Dir/2 for File: 2
Enter Name of dir/file(under USER2): SUBDIR2
Enter 1 for Dir/2 for File: 1
No of subdirectories/files(for SUBDIR2): 2
Enter Name of dir/file(under SUBDIR2):PPL
Enter 1 for Dir/2 for File: 1
No of subdirectories/files(for PPL): 2
Enter Name of dir/file(under PPL): B
Enter 1 for Dir/2 for File: 2
Enter Name of dir/file(under PPL): C
Enter 1 for Dir/2 for File: 2

```

EnterName of dir/file(underSUBDIR): AI
 Enter 1 for Dir/2 for File: 1
 No of subdirectories/files(for AI): 2
 Enter Name of dir/file(under AI): D
 Enter 1 for Dir/2 for File: 2
 Enter Name of dir/file(under AI): E
 Enter 1 for Dir/2 for File: 2

OUTPUT



DAG

```

#include<stdio.h>
#include<conio.h>
#include<graphics.h>
#include<string.h> struct
tree_element
{
char name[20];
int x,y,ftype,lx,rx,nc,level;
struct tree_element *link[5];
};
typedef struct tree_element node; typedef
struct
{
char from[20];
char to[20];
}link;
link L[10]; int nofl;
node * root;
void main()
{
int gd=DETECT,gm;
root=NULL;
clrscr();
create(&root,0,"root",0,639,320);
read_links();
clrscr();
initgraph(&gd,&gm,"c:\tc\BGI");
draw_link_lines();

```

```

display(root);
getch();
closegraph();
}
read_links()
{
int i;
printf("how many links");
scanf("%d",&nofl);
for(i=0;i<nofl;i++)
{
printf("File/dir:");
fflush(stdin);
gets(L[i].from);
printf("user name:");
fflush(stdin);
gets(L[i].to);
}
}
}
draw_link_lines()
{
int i,x1,y1,x2,y2;
for(i=0;i<nofl;i++)
{
search(root,L[i].from,&x1,&y1);
search(root,L[i].to,&x2,&y2);
setcolor(LIGHTGREEN);
setlinestyle(3,0,1);
line(x1,y1,x2,y2);
setcolor(YELLOW);
setlinestyle(0,0,1);
}
}
search(node *root,char *s,int *x,int *y)
{
int i;
if(root!=NULL)
{
if(strcmpi(root->name,s)==0)
{
*x=root->x;
*y=root->y;
return;
}
else
{
for(i=0;i<root->nc;i++)
search(root->link[i],s,x,y);
}
}
}
create(node **root,int lev,char *dname,int lx,int rx,int x)
{
int i,gap;
if(*root==NULL)
{
(*root)=(node *)malloc(sizeof(node));
printf("enter name of dir/file(under %s):",dname); fflush(stdin);

```

```

gets((*root)->name); printf("enter
1 for dir/ 2 for file:");
scanf("%d",&(*root)->ftype); (*root)->level=lev;
(*root)->y=50+lev*50;
(*root)->x=x;
(*root)->lx=lx;
(*root)->rx=rx;
for(i=0;i<5;i++)
(*root)-
>link[i]=NULL;
if((*root)->ftype==1)
{
printf("no of sub directories /files (for %s):",(*root)->name);
scanf("%d",&(*root)->nc);
if((*root)->nc==0)
gap=rx-lx;
else
gap=(rx-lx)/(*root)->nc;
for(i=0;i<(*root)->nc;i++)
create( & ( (*root)->link[i] ) , lev+1 ,
(*root)->name,lx+gap*i,lx+gap*i+gap,lx+gap*i+gap/2);
}
else (*root)->nc=0;
}
}
/* displays the constructed tree in graphics mode */
display (node *root)
{
int i;
settextstyle(2,0,4);
settextjustify(1,1);
setfillstyle(1,BLUE);
setcolor(14); if(root
!=NULL)
{
for(i=0;i<root->nc;i++)
{
line(root->x,root->y,root->link[i]->x,root->link[i]->y);
}
if(root->ftype==1) bar3d(root->x-20,root->y-10,root->x+20,root->y+10,0,0); else
fillemnipse(root->x,root->y,20,20);
outtextxy(root->x,root->y,root->name);
for(i=0;i<root->nc;i++)
{
display (root->link[i]);
}
}
}
}

```

OUTPUT:

```

Enter Name of dir/file (under root): ROOT
Enter 1 for Dir /2 For File : 1
No of subdirectories / files (for ROOT) :2
EnterNameofdir/file(underROOT):USER1
Enter 1 for Dir /2 for file:1
No of subdirectories /files (for USER1): 2
Enter Name of dir/file (under USER1): VB

```

Enter 1 for Dir /2 for file:1
No of subdirectories/files (for VB):2
Enter Name of dir/file (under VB): A
Enter 1 for Dir /2 for file:2
Enter Name of dir/file (under VB): B
Enter 1 for Dir /2 for file:2
Enter Name of dir/file (under USER1): C Enter 1
for Dir /2 for file:2
Enter Name of dir/file (under ROOT): USER2
Enter 1 for Dir /2 for file:1
No of subdirectories/files (for USER2): 1 Enter
Name of dir/file (under USER2): JAVA Enter 1 for
Dir /2 for file:1
No of subdirectories /files (for JAVA):2
Enter Name of dir/file (under JAVA):D
Enter 1 for Dir /2 for file:2
Enter Name of dir/file (under JAVA):HTML
Enter 1 for Dir /2 for file:1
No of subdirectories /files (for HTML):0
How many links:2
File/Dir: B
User Name:
USER2
File/Dir:
HTML User
Name:
USER1

EXPERIMENT 7

OBJECTIVE

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

DESCRIPTION

In a multiprogramming environment, several processes may compete for a finite number of resources. A process requests resources; if the resources are not available at that time, the process enters a waiting state. Sometimes, a waiting process is never again able to change state, because the resources it has requested are held by other waiting processes. This situation is called a deadlock. Deadlock avoidance is one of the techniques for handling deadlocks. This approach requires that the operating system be given in advance additional information concerning which resources a process will request and use during its lifetime. With this additional knowledge, it can decide for each request whether or not the process should wait. To decide whether the current request can be satisfied or must be delayed, the system must consider the resources currently available, the resources currently allocated to each process, and the future requests and releases of each process. Banker's algorithm is a deadlock avoidance algorithm that is applicable to a system with multiple instances of each resource type.

Deadlock avoidance.

```
#include<stdio.h> struct
file
{
    int all[10];
    int max[10];
    int need[10];
    int flag;
};
void main()
{
    struct file f[10];
    int fl;
    int i, j, k, p, b, n, r, g, cnt=0, id, newr;
    int avail[10], seq[10];
    clrscr();
    printf("Enter number of processes -- ");
    scanf("%d", &n);
    printf("Enter number of resources -- ");
    scanf("%d", &r);
    for(i=0; i<n; i++)
    {
        printf("Enter details for P%d", i);
        printf("\nEnter allocation\t -- \t");
        for(j=0; j<r; j++)
            scanf("%d", &f[i].all[j]);
        printf("Enter Max\t\t -- \t");
        for(j=0; j<r; j++)
            scanf("%d", &f[i].max[j]);
        f[i].flag=0;
    }
    printf("\nEnter Available Resources\t -- \t");
    for(i=0; i<r; i++)
        scanf("%d", &avail[i]);

    printf("\nEnter New Request Details -- ");
    printf("\nEnter pid \t -- \t");
    scanf("%d", &id);
    printf("Enter Request for Resources\t -- \t");
    for(i=0; i<r; i++)
```

```

    {
        scanf("%d",&newr);
        f[id].all[i] += newr;
        avail[i]=avail[i] - newr;
    }

for(i=0;i<n;i++)
{
    for(j=0;j<r;j++)
    {
        f[i].need[j]=f[i].max[j]-f[i].all[j];
        if(f[i].need[j]<0)
            f[i].need[j]=0;
    }
}
cnt=0;
fl=0;
while(cnt!=n)
{
    g=0;
    for(j=0;j<n;j++)
    {
        if(f[j].flag==0)
        {
            b=0;
            for(p=0;p<r;p++)
            {
                if(avail[p]>=f[j].need[p])
                    b=b+1;
                else
                    b=b-1;
            }
            if(b==r)
            {
                printf("\nP%d is visited",j);
                seq[fl++]=j;
                f[j].flag=1;
                for(k=0;k<r;k++)
                    avail[k]=avail[k]+f[j].all[k]
                ; cnt=cnt+1;
                printf("");
                for(k=0;k<r;k++)
                    printf("%3d",avail[k]);
                printf("");
                g=1;
            }
        }
    }
    if(g==0)
    {
        printf("\n REQUEST NOT GRANTED -- DEADLOCK OCCURRED");
        printf("\n SYSTEM IS IN UNSAFE STATE");
        goto y;
    }
}
printf("\nSYSTEM IS IN SAFE STATE");
printf("\nThe Safe Sequence is -- (");
for(i=0;i<fl;i++)
    printf("P%d ",seq[i]);
printf(")");
y: printf("\nProcess\tAllocation\tMax\tNeed\n");
for(i=0;i<n;i++)

```

```

        {
            printf("P%d\t",i);
            for(j=0;j<r;j++)
                printf("%6d",f[i].all[j]); for(j=0;j<r;j++)
                printf("%6d",f[i].max[j]); for(j=0;j<r;j++)
                printf("%6d",f[i].need[j]); printf("\n");
        }
    getch();
}

```

INPUT

```

Enter number of processes      --      5
Enter number of resources     --      3
Enter details for P0
Enter allocation               --      0      1      0
Enter Max

Enter details for P1
Enter allocation               --      2      0      0
Enter Max

Enter details for P2
Enter allocation               --      3      0      2
Enter Max

Enter details for P3
Enter allocation               --      2      1      1
Enter Max

Enter details for P4
Enter allocation               --      0      0      2
Enter Max

Enter Available Resources     --      3      3      2
Enter New Request Details --
Enter pid      --      1
Enter Request for Resources   --      1      0      2

```

OUTPUT

```

P1 is visited( 5 3 2)
P3 is visited( 7 4 3)
P4 is visited( 7 4 5)
P0 is visited( 7 5 5)
P2 is visited( 10 5 7)
SYSTEM IS IN SAFE STATE
The Safe Sequence is -- (P1 P3 P4 P0 P2)

```

Process	Allocation	Max	Need
P0	0 1 0	7 5 3	7 4 3
P1	3 0 2	3 2 2	0 2 0
P2	3 0 2	9 0 2	6 0 0
P3	2 1 1	2 2 2	0 1 1
P4	0 0 2	4 3 3	4 3 1

EXPERIMENT 8

OBJECTIVE

Simulate Bankers algorithm for dead lock prevention

DESCRIPTION

We can prevent Deadlock by eliminating any of the above four Mutual Exclusion. Hold and Wait. No preemption. Circular wait condition. Eliminate Mutual Exclusion It is not possible to dis-satisfy the mutual exclusion because some resources, such as the tap drive and printer, are inherently non-shareable. Eliminate Hold and wait, Allocate all required resources to the process before start of its execution, this way hold and wait condition is eliminated but it will lead to low device utilization.

```
#include< stdio.h>
#include< conio.h>
void main()
{
int allocated[15][15],max[15][15],need[15][15],avail[15],tres[15],work[15],flag[15]; int
pno,rno,i,j,prc,count,t,total;
count=0;
clrscr();

printf("\n Enter number of process:");
scanf("%d",&pno);
printf("\n Enter number of resources:");
scanf("%d",&rno);
for(i=1;i<=pno;i++)
{
flag[i]=0;
}

printf("\n Enter total numbers of each resources:");
for(i=1;i<= rno;i++)
scanf("%d",&tres[i]);

printf("\n Enter Max resources for each process:");
for(i=1;i<= pno;i++)
{
printf("\n for process %d:",i);
for(j=1;j<= rno;j++)
scanf("%d",&max[i][j]);
}

printf("\n Enter allocated resources for each process:"); for(i=1;i<=
pno;i++)
{
printf("\n for process %d:",i);
for(j=1;j<= rno;j++)
scanf("%d",&allocated[i][j]);
}
printf("\n available resources:\n");
for(j=1;j<= rno;j++)
{
avail[j]=0;
total=0;
for(i=1;i<= pno;i++)
```

```

{
total+=allocated[i][j];
}
avail[j]=tres[j]-total;
work[j]=avail[j];
printf("  %d\t",work[j]);
}
do
{
for(i=1;i<= pno;i++)
{
for(j=1;j<= rno;j++)
{
need[i][j]=max[i][j]-allocated[i][j];
}
}
printf("\n Allocated matrix      Max      need");
for(i=1;i<= pno;i++)
{
printf("\n");
for(j=1;j<=rno;j++)
{
printf("%4d",allocated[i][j]);
}
printf("|");
for(j=1;j<= rno;j++)
{
printf("%4d",max[i][j]);
}
printf("|");
for(j=1;j<= rno;j++)
{
printf("%4d",need[i][j]);
}
}
prc=0;

for(i=1;i<= pno;i++)
{
if(flag[i]==0)
{
prc=i;

for(j=1;j<= rno;j++)
{
if(work[j]< need[i][j])
{
prc=0;
break;
}
}
}
}

if(prc!=0)
break;
}
if(prc!=0)
{
printf("\n Process %d completed",i);

```

```

count++;
printf("\n Available matrix:");
for(j=1;j<= rno;j++)
{
work[j]+=allocated[prc][j];
allocated[prc][j]=0;
max[prc][j]=0;
flag[prc]=1;
printf(" %d",work[j]);
}
}

while(count!=pno&&prc!=0);
if(count==pno)
printf("\nThe system is in a safe state!!");
else
printf("\nThe system is in an unsafe state!!"); getch();
}

```

OUTPUT

Enter number of process:5

Enter number of resources:3

Enter total numbers of each resources:10 5 7

Enter Max resources for each process: for
process 1:7 5 3

for process 2:3 2 2

for process 3:9 0 2

for process 4:2 2 2

for process 5:4 3 3

Enter allocated resources for each process: for
process 1:0 1 0

for process 2:3 0 2

for process 3:3 0 2

for process 4:2 1 1

for process 5:0 0 2 available

resources:

2 3 0

Allocated matrix Max need

0 1 0 | 7 5 3 | 7 4 3

3 0 2 | 3 2 2 | 0 2 0

3 0 2| 9 0 2| 6 0 0
 2 1 1| 2 2 2| 0 1 1
 0 0 2| 4 3 3| 4 3 1

Process 2 completed

Available matrix: 5 3 2 Allocated
 matrix Max need

0 1 0| 7 5 3| 7 4 3
 0 0 0| 0 0 0| 0 0 0
 3 0 2| 9 0 2| 6 0 0
 2 1 1| 2 2 2| 0 1 1
 0 0 2| 4 3 3| 4 3 1

Process 4 completed

Available matrix: 7 4 3 Allocated
 matrix Max need

0 1 0| 7 5 3| 7 4 3
 0 0 0| 0 0 0| 0 0 0
 3 0 2| 9 0 2| 6 0 0
 0 0 0| 0 0 0| 0 0 0
 0 0 2| 4 3 3| 4 3 1

Process 1 completed

Available matrix: 7 5 3 Allocated
 matrix Max need

0 0 0| 0 0 0| 0 0 0
 0 0 0| 0 0 0| 0 0 0
 3 0 2| 9 0 2| 6 0 0
 0 0 0| 0 0 0| 0 0 0
 0 0 2| 4 3 3| 4 3 1

Process 3 completed

Available matrix: 10 5 5

Allocated matrix Max need

0 0 0| 0 0 0| 0 0 0
 0 0 0| 0 0 0| 0 0 0
 0 0 0| 0 0 0| 0 0 0
 0 0 0| 0 0 0| 0 0 0
 0 0 2| 4 3 3| 4 3 1

Process 5 completed

Available matrix: 10 5 7 The
 system is in a safe state!!

EXPERIMENT 9

OBJECTIVE

Write a C program to simulate page replacement algorithms FIFO

DESCRIPTION

Page replacement is basic to demand paging. It completes the separation between logical memory and physical memory. With this mechanism, an enormous virtual memory can be provided for programmers on a smaller physical memory. There are many different page-replacement algorithms. Every operating system probably has its own replacement scheme. A FIFO replacement algorithm associates with each page the time when that page was brought into memory.

PROGRAM

FIFO PAGE REPLACEMENT ALGORITHM

```
#include<stdio.h>
#include<conio.h>
main()
{
    int i,j,k,f, pf=0, count=0, rs[25], m[10], n;
    clrscr();
    printf("\n Enter the length of reference string -- ");
    scanf("%d",&n);
    printf("\n Enter the reference string -- ");
    for(i=0;i<n;i++)
        scanf("%d",&rs[i]);
    printf("\n Enter no. of frames -- ");
    scanf("%d",&f);
    for(i=0;i<f;i++)
        m[i]=-1;

    printf("\n The Page Replacement Process is -- \n");
    for(i=0;i<n;i++)
    {
        for(k=0;k<f;k++)
        {
            if(m[k]==rs[i])
                break;
        }
        if(k==f)
        {
            m[count++]=rs[i];
            pf++;
        }
        for(j=0;j<f;j++)
            printf("\t%d",m[j]);
        if(k==f)
            printf("\tPF No. %d",pf);
        printf("\n");
        if(count==f)
            count=0;
    }
    printf("\n The number of Page Faults using FIFO are %d",pf);
    getch();
}
```

INPUT

Enter the length of reference string – 20

Enter the reference string --70120304230321201701 Enter

no. of frames -- 3

OUTPUT

The Page Replacement Process is –

7	-1	-1	PF No. 1
7	0	-1	PF No. 2
7	0	1	PF No. 3
2	0	1	PF No. 4
2	0	1	
2	3	1	PF No. 5
2	3	0	PF No. 6
4	3	0	PF No. 7
4	2	0	PF No. 8
4	2	3	PF No. 9
0	2	3	PF No. 10
0	2	3	
0	2	3	
0	1	3	PF No. 11
0	1	2	PF No. 12
0	1	2	
0	1	2	
7	1	2	PF No. 13
7	0	2	PF No. 14
7	0	1	PF No. 15

EXPERIMENT 10

OBJECTIVE

Write a C program to simulate page replacement algorithms LRU

DESCRIPTION

When a page must be replaced, the oldest page is chosen. If the recent past is used as an approximation of the near future, then the page that has not been used for the longest period of time can be replaced. This approach is the Least Recently Used (LRU) algorithm. LRU replacement associates with each page the time of that page's last use. When a page must be replaced, LRU chooses the page that has not been used for the longest period of time

```
#include<stdio.h>
#include<conio.h>
main()
{
int i,j,k,min,rs[25],m[10],count[10],flag[25],n,f,pf=0,next=1;clrscr(); printf("Enter
the length of reference string -- ");
scanf("%d",&n);
printf("Enter the reference string -- ");
for(i=0;i<n;i++)
{
scanf("%d",&rs[i]); flag[i]=0;
}
printf("Enter the number of frames -- "); scanf("%d",&f); for(i=0;i<f;i++)
{
count[i]=0; m[i]=-1;
}
printf("\n\nThe Page Replacement process is -- \n");
for(i=0;i<n;i++)
{
for(j=0;j<f;j++)
{
if(m[j]==rs[i])
{
flag[i]=1;
count[j]=next;
next++;
}
}
if(flag[i]==0)
{
if(i<f)
{
m[i]=rs[i];
count[i]=next;
next++;
}
else
{
min=0;
for(j=1;j<f;j++)
if(count[min]>count[j])min=j;
m[min]=rs[i];
count[min]=next;
next++;
}
}
}
```

```

    pf++;
}
for(j=0;j<f;j++)
printf("%d\t", m[j]);
if(flag[i]==0)
printf("PF No. -- %d", pf);
printf("\n");
}
printf("\n\nThe number of page faults using LRU are %d",pf);
getch();
}

```

INPUT

Enter the length of reference string -- 20

Enter the reference string -- 70120304230321201701 Enter
the number of frames -- 3

OUTPUT

The Page Replacement process is --

```

7  -1  -1  PF No. -- 1
7   0  -1  PF No. -- 2
7   0   1  PF No. -- 3
2   0   1  PF No. -- 4
2   0   1
2   0   3  PF No. -- 5
2   0   3
4   0   3  PF No. -- 6
4   0   2  PF No. -- 7
4   3   2  PF No. -- 8
0   3   2  PF No. -- 9
0   3   2
0   3   2
1   3   2  PF No. -- 10
1   3   2
1   0   2  PF No. -- 11
1   0   2
1   0   7  PF No. -- 12
1   0   7
1   0   7

```

The number of page faults using LRU are 12

EXPERIMENT 11

OBJECTIVE

Write a C program to simulate page replacement algorithms LRU

DESCRIPTION

When a page must be replaced, LRU chooses the page that has not been used for the longest period of time. Least frequently used (LFU) page-replacement algorithm requires that the page with the smallest count be replaced. The reason for this selection is that an actively used page should have a large reference count.

LFU PAGE REPLACEMENT ALGORITHM

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

main()
{
intrs[50], i, j, k, m, f, cntr[20], a[20], min, pf=0;
clrscr();
printf("\nEnter number of page references -- ");
scanf("%d",&m);
printf("\nEnter the reference string -- ");
for(i=0; i<m; i++)
scanf("%d",&rs[i]);
printf("\nEnter the available no. of frames -- ");
scanf("%d",&f);
for(i=0; i<f; i++)
{
cntr[i]=0;
a[i]=-1;
}
Printf("\nThe Page Replacement Process is -\n");
for(i=0; i<m; i++)
{
for(j=0; j<f; j++)
if(rs[i]==a[j])
{
cntr[j]++;
break;
if(j==f)
{
min = 0;
for(k=1; k<f; k++)
if(cntr[k]<cntr[min]) min=k;
a[min]=rs[i];
cntr[min]=1;
pf++;
}
printf("\n");
for(j=0; j<f; j++)
printf("\t%d", a[j]);
if(j==f)
printf("\tPF No. %d", pf);
}
printf("\n\nTotal number of page faults -- %d", pf);
getch();
}
```

INPUT Enter number of page references -- 10 Enter
the reference string -- 1 2 3 4 5 2 5 2 5 1 4 3 Enter the
available no. of frames -- 3 4 0

OUTPUT

1	-1	-1	PF No. 1
1	2	-1	PF No. 2
1	2	3	PF No. 3
4	2	3	PF No. 4
5	2	3	PF No. 5
5	2	3	
5	2	3	
5	2	1	PF No. 6
5	2	4	PF No. 7
5	2	3	PF No. 8

Total number of page faults -- 8

EXPERIMENT 12

OBJECTIVE

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

DESCRIPTION

In computer operating systems, paging is one of the memory management schemes by which a computer stores and retrieves data from the secondary storage for use in main memory. In the paging memory-management scheme, the operating system retrieves data from secondary storage in same-size blocks called pages. Paging is a memory-management scheme that permits the physical address space a process to be noncontiguous. The basic method for implementing paging involves breaking physical memory into fixed-sized blocks called frames and breaking logical memory into blocks of the same size called pages. When a process is to be executed, its pages are loaded into any available memory frames from their source.

PROGRAM

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

main()
{
    int ms, ps, nop, np, rempages, i, j, x, y, pa, offset; int
    s[10], fno[10][20];

    clrscr();

    printf("\nEnter the memory size-- ");
    scanf("%d", &ms);

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

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

    printf("\nEnter number of processes -- ");
    scanf("%d", &np);

    rempages = nop;

    for(i=1; i<=np; i++)
    {

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

        if(s[i] > rempages)
        {
            printf("\nMemory is Full");
            break;
        }

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

```

printf("\nEnter Logical Address to find Physical Address ");
printf("\nEnter process no. and pagenumber and offset -- ");
scanf("%d %d %d",&x,&y, &offset);
if(x>np || y>=s[i] || offset>=ps)
    printf("\nInvalid Process or Page Number or offset");
else
{
    pa=fno[x][y]*ps+offset;
    printf("\nThe Physical Address is -- %d",pa);
}
getch();
}

```

INPUT

Enter the memory size – 1000
Enter the page size -- 100
The no. of pages available in memory are -- 10

Enter number of processes -- 3
Enter no. of pages required for p[1]-- 4
Enter pagetable for p[1]--- 8 6 9 5

Enter no. of pages required for p[2]-- 5
Enter pagetable for p[2]--- 1 4 5 7 3

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

OUTPUT

Memory is Full

Enter Logical Address to find Physical Address Enter
process no. and pagenumber and offset -- 2 3 60
The Physical Address is -- 760

LAB QUESTIONS & ASSIGNMENTS

EXPERIMENT 1

PRE-LAB QUESTIONS

1. Define operating system?
2. What are the different types of operating systems?
3. Define a process?
4. What is CPU Scheduling?
5. Define arrival time, burst time, waiting time, turnaround time?

POST-LAB QUESTIONS

1. What is the advantage of round robin CPU scheduling algorithm?
2. Which CPU scheduling algorithm is for real-time operating system?
3. In general, which CPU scheduling algorithm works with highest waiting time?
4. Is it possible to use optimal CPU scheduling algorithm in practice?
5. What is the real difficulty with the SJF CPU scheduling algorithm?

ASSIGNMENT QUESTIONS

1. Write a C program to implement round robin CPU scheduling algorithm for the following given scenario. All the processes in the system are divided into two categories – system processes and user processes. System processes are to be given higher priority than user processes. Consider the time quantum size for the system processes and user processes to be 5 msec and 2 msec respectively.
2. Write a C program to simulate pre-emptive SJF CPU scheduling algorithm.

EXPERIMENT 2

PRE-LAB QUESTIONS

1. What is multi-level queue CPU Scheduling?
2. Differentiate between the general CPU scheduling algorithms like FCFS, SJF etc and multi-level queue CPU Scheduling?
3. What are CPU-bound I/O-bound processes?

POST-LAB QUESTIONS

1. What are the parameters to be considered for designing a multilevel feedback queue scheduler?
2. Differentiate multi-level queue and multi-level feedback queue CPU scheduling algorithms?
3. What are the advantages of multi-level queue and multi-level feedback queue CPU scheduling algorithms?

ASSIGNMENT QUESTIONS

1. Write a C program to simulate multi-level queue scheduling algorithm considering the following scenario. All the processes in the system are divided into two categories – system processes and user processes. System processes are to be given higher priority than user processes. Consider each process priority to be from 1 to 3. Use priority scheduling for the processes in each queue.

EXPERIMENT 3

PRE-LAB QUESTIONS

1. Define file?
2. What are the different kinds of files?
3. What is the purpose of file allocation strategies?

POST-LAB QUESTIONS

1. Identify ideal scenarios where sequential, indexed and linked file allocation strategies are most appropriate?
2. What are the disadvantages of sequential file allocation strategy?
3. What is an index block?
4. What is the file allocation strategy used in UNIX?

ASSIGNMENT QUESTIONS

1. Write a C program to simulate a two-level index scheme for file allocation?

EXPERIMENT 4

PRE-LAB QUESTIONS

1. What is the purpose of memory management unit?
2. Differentiate between logical address and physical address?
3. What are the different types of address binding techniques?
4. What is the basic idea behind contiguous memory allocation?
5. How is dynamic memory allocation useful in multiprogramming operating systems?

POST-LAB QUESTIONS

1. Differentiate between equal sized and unequal sized MFT schemes?
2. What is the advantage of MVT memory management scheme over MFT?

ASSIGNMENT QUESTIONS

1. Write a C program to simulate MFT memory management scheme with unequal sized partitions.

EXPERIMENT 5

PRE-LAB QUESTIONS

1. Differentiate between the memory management schemes MFT and MVT?
2. What is dynamic memory allocation?
3. What is external fragmentation?

POST-LAB QUESTIONS

1. Which of the dynamic contiguous memory allocation strategies suffer with external fragmentation?
2. What are the possible solutions for the problem of external fragmentation?
3. What is 50-percent rule?
4. What is compaction?
5. Which of the memory allocation techniques first-fit, best-fit, worst-fit is efficient? Why?

ASSIGNMENT QUESTIONS

1. Write a C program to implement compaction technique.

EXPERIMENT 6

PRE-LAB QUESTIONS

1. What are the advantages of noncontiguous memory allocation schemes?
2. What is the process of mapping a logical address to physical address with respect to the paging memory management technique?
3. Define the terms – base address, offset?

POST-LAB QUESTIONS

1. Differentiate between paging and segmentation memory allocation techniques?
2. What is the purpose of page table?
3. Whether the paging memory management technique suffers with internal or external fragmentation problem. Why?
4. What is the effect of paging on the overall context-switching time?

ASSIGNMENT QUESTIONS

1. Write a C program to simulate two-level paging technique.
2. Write a C program to simulate segmentation memory management technique.

EXPERIMENT 7

PRE-LAB QUESTIONS

1. Define directory?
2. Describe the general directory structure?
3. List the different types of directory structures?

POST-LAB QUESTIONS

1. Which of the directory structures is efficient? Why?
2. Which directory structure does not provide user-level isolation and protection?
3. What is the advantage of hierarchical directory structure?

ASSIGNMENT QUESTIONS

1. Write a C to simulate acyclic graph directory structure?
2. Write a C to simulate general graph directory structure?

EXPERIMENT 8

PRE-LAB QUESTIONS

1. Define resource. Give examples.
2. What is deadlock?
3. What are the conditions to be satisfied for the deadlock to occur?

POST-LAB QUESTIONS

1. How can be the resource allocation graph used to identify a deadlock situation?
2. How is Banker's algorithm useful over resource allocation graph technique?
3. Differentiate between deadlock avoidance and deadlock prevention?

ASSIGNMENT QUESTIONS

1. Write a C program to implement deadlock detection technique for the following scenarios?
 - a. Single instance of each resource type
 - b. Multiple instances of each resource type

EXPERIMENT 9

PRE-LAB QUESTIONS

1. What is disk scheduling?
2. List the different disk scheduling algorithms?
3. Define the terms – disks seek time, disk access time and rotational latency?

POST-LAB QUESTIONS

1. What is the advantage of C-SCAN algorithm over SCAN algorithm?
2. Which disk scheduling algorithm has highest rotational latency? Why?

ASSIGNMENT QUESTIONS

1. Write a C program to implement SSTF disk scheduling algorithm?

EXPERIMENT 10

PRE-LAB QUESTIONS

1. Define the concept of virtual memory?
2. What is the purpose of page replacement?
3. Define the general process of page replacement?
4. List out the various page replacement techniques?
5. What is pagefault?

POST-LAB QUESTIONS

1. Which page replacement algorithm suffers with the problem of Belady's anomaly?
2. Define the concept of thrashing? What is the scenario that leads to the situation of thrashing?

ASSIGNMENT QUESTIONS

1. Write a C program to simulate LRU-approximation page replacement algorithm?
 - a. Additional-Reference bits algorithm
 - b. Second-chance algorithm

EXPERIMENT 11

PRE-LAB QUESTIONS

1. What are the benefits of optimal page replacement algorithm over other page replacement algorithms?

POST-LAB QUESTIONS

1. Why can't the optimal page replacement technique be used in practice?

EXPERIMENT 12

PRE-LAB QUESTIONS

1. What is the need for process synchronization?
2. Define a semaphore?
3. Define producer-consumer problem?

POST-LAB QUESTIONS

1. Discuss the consequences of considering bounded and unbounded buffers in producer-consumer problem?
2. Can producer and consumer processes access the shared memory concurrently? If not which technique provides such a benefit?

ASSIGNMENT QUESTIONS

1. Write a C program to simulate producer-consumer problem using message-passing system.