SRM VALLIAMMAI ENGINEERING COLLEGE

SRM Nagar, Kattankulathur-603203.

**DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING**

# LAB MANUAL

# IT3464 OPERATING SYSTEMS LABORATORY

(IV SEMESTER)

PREPARED BY

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**IT3464 OPERATING SYSTEMS LABORATORY L T P C 0 0 3 1.5**

**OBJECTIVES:**

- To understand the basics of Unix command and shell programming.
- To implement various CPU scheduling algorithms.
- To implement Deadlock Avoidance and Deadlock Detection Algorithms
- To implement Page Replacement Algorithms
- To implement various memory allocation methods and File Organization, File Allocation Strategies.

**LIST OF EXPERIMENTS:**

1. UNIX commands and Basic Shell Programming

2. Process Management using System Calls : Fork, Exit, Getpid, Wait, Close

3. Write C programs to implement the various CPU Scheduling Algorithms

4. Implement mutual exclusion by Semaphore

5. Write C programs to avoid Deadlock using Banker's Algorithm

6. Write a C program to Implement Deadlock Detection Algorithm

7. Write C program to implement Threading

8. Write C program to Implement the paging Technique.

9. Write C programs to implement the following Memory Allocation Methods

a. First Fit b.Worst Fit c. Best Fit

10 Write C programs to implement the various Page Replacement Algorithms

11. Write C programs to Implement the various File Organization Techniques

12. Implement the following File Allocation Strategies using C programs

a. Sequential b. Indexed c. Linked

13. Write C programs for the implementation of various disk scheduling algorithms

TOTAL: 45 PERIODS

Software Requirements:

Standalone desktops with C / C++ / Java / Equivalent complier 30 Nos.

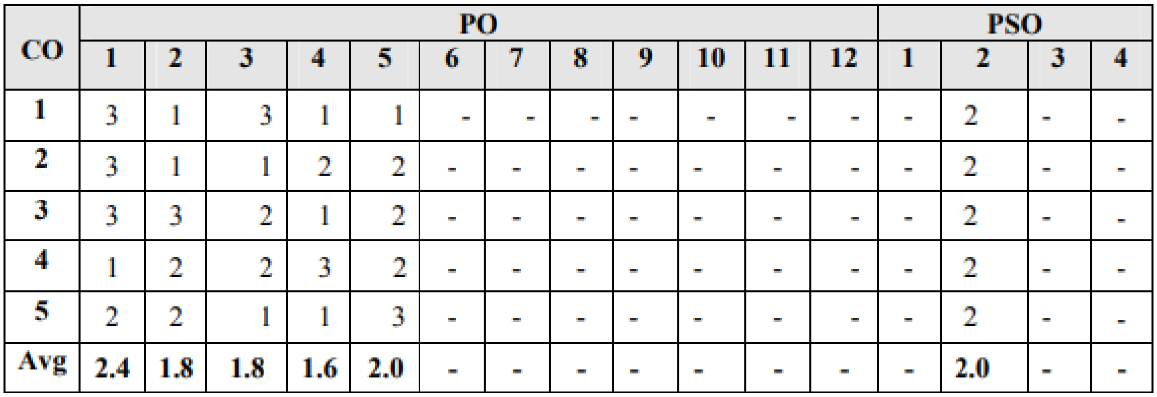
(or) Server with C / C++ / Java / Equivalent complier supporting 30 terminals or more

**COURSE OUTCOMES:**

At the end of this course, the students will be able to:

- Define and implement UNIX Commands.
- Compare the performance of various CPU Scheduling Algorithms.
- Compare and contrast various Memory Allocation Methods.
- Define File Organization and File Allocation Strategies.
- Implement various Disk Scheduling Algorithms

**CO – PO – PSO Mapping**



| CO | PO | | | | | | | | | | | | PSO | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 |
| 1 | 3 | 1 | 3 | 1 | 1 | - | - | - | - | - | - | - | - | 2 | - | - |
| 2 | 3 | 1 | 1 | 2 | 2 | - | - | - | - | - | - | - | - | 2 | - | - |
| 3 | 3 | 3 | 2 | 1 | 2 | - | - | - | - | - | - | - | - | 2 | - | - |
| 4 | 1 | 2 | 2 | 3 | 2 | - | - | - | - | - | - | - | - | 2 | - | - |
| 5 | 2 | 2 | 1 | 1 | 3 | - | - | - | - | - | - | - | - | 2 | - | - |
| Avg | 2.4 | 1.8 | 1.8 | 1.6 | 2.0 | - | - | - | - | - | - | - | - | 2.0 | - | - |

**EX NO: 1**

## BASICS OF UNIX COMMANDS

## Aim

To study and execute Unix commands.

Unix is security conscious, and can be used only by those persons who have an account.

Telnet (Telephone Network) is a Terminal emulator program for TCP/IP networks thatenables users to log on to remote servers.

To logon, type **telnet** server_ipaddressin**run** window.

User has to authenticate himself by providing username and password. Once verified, agreeting and **$** prompt appears. The shell is now ready to receive commands from the user.

Options suffixed with a hyphen (–) and arguments are separated by space.

## General commands

| **Command** | **Function** |
|---|---|
| `date` | Used to display the current system date and time. |
| `date +%D` | Displays date only |
| `date +%T` | Displays time only |
| `date +% Y` | Displays the year part of date |
| `date +% H` | Displays the hour part of time |
| `cal` | Calendar of the current month |
| `cal`year | Displays calendar for all months of the specified year |
| `cal`month year | Displays calendar for the specified month of the year |
| `who` | Login details of all users such as their IP, Terminal No, User name, |
| `who am i` | Used to display the login details of the user |
| `tty` | Used to display the terminal name |
| `uname` | Displays the Operating System |
| `uname –r` | Shows version number of the OS (kernel). |
| `uname –n` | Displays domain name of the server |
| `echo` "txt" | Displays the given text on the screen |
| `echo $HOME` | Displays the user's home directory |
| `bc` | Basic calculator. Press **Ctrl+d**to quit |
| `lp`file | Allows the user to spool a job along with others in a print queue. |
| `man` cmdname | Manual for the given command. Press **q** to exit |
| `history` | To display the commands used by the user since log on. |
| `exit` | Exit from a process. If shell is the only process then logs out |

## Directory commands

| **Command** | **Function** |
|---|---|
| `pwd` | Path of the present working directory |
| `mkdir`dir | A directory is created in the given name under the current directory |
| `mkdir`dir1 dir2 | A number of sub-directories can be created under one stroke |

| | |
|---|---|
| `cd` subdir | Change Directory. If the subdirstarts with / then path starts from **root** (absolute) otherwise from current working directory. |
| `cd` | To switch to the home directory. |
| `cd /` | To switch to the root directory. |
| `cd..` | To move back to the parent directory |
| `rmdir`subdir | Removes an empty sub-directory. |

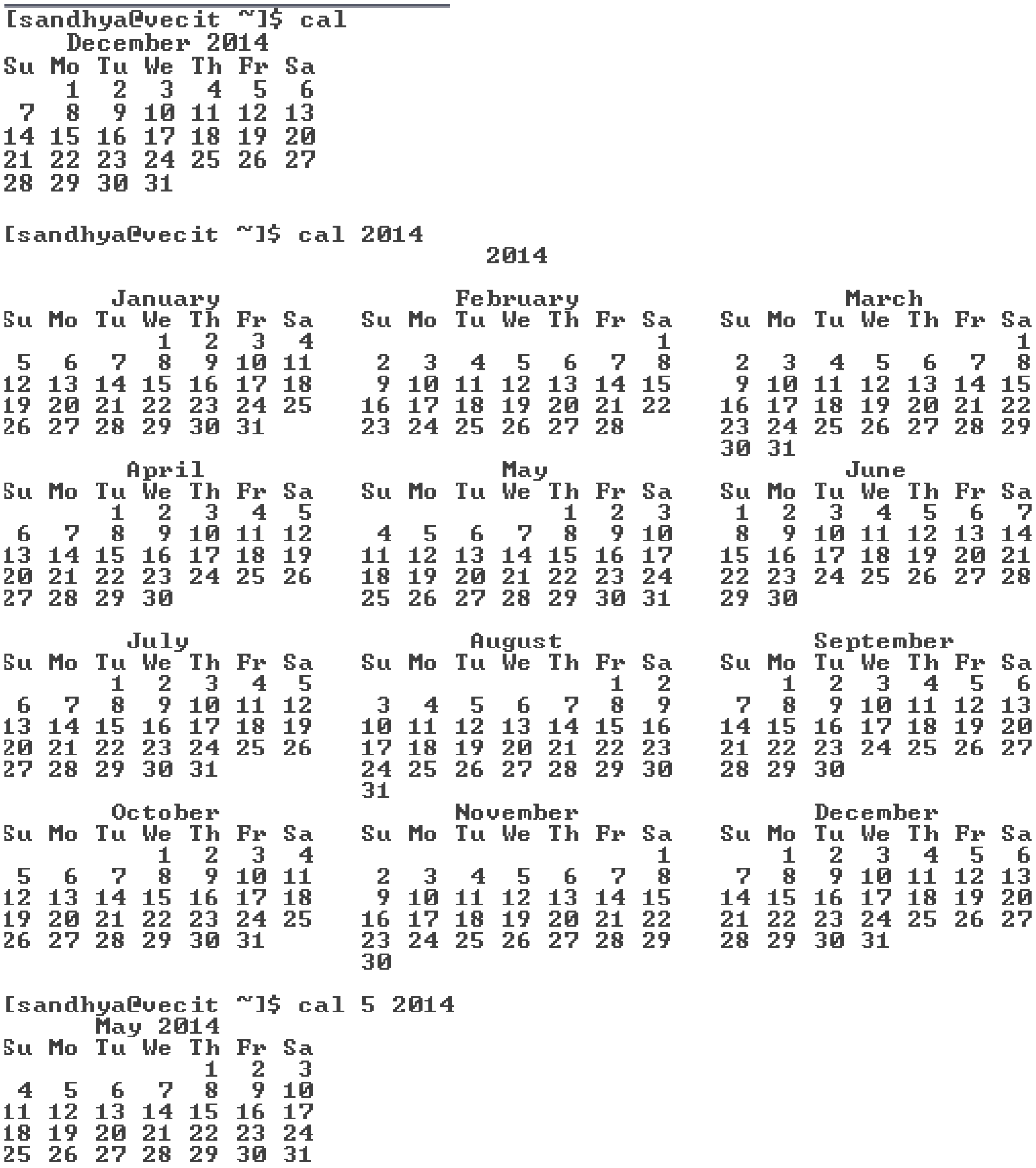
## File commands

| **Command** | **Function** |
|---|---|
| `cat` >filename | To create a file with some contents. To end typing press **Ctrl+d**. The >symbol means redirecting output to a file. (<for input) |
| `cat` filename | Displays the file contents. |
| `cat` >>filename | Used to append contents to a file |
| `cp`src des | Copy files to given location. If already exists, it will be overwritten |
| `cp -i` src des | Warns the user prior to overwriting the destination file |
| `cp -r` src des | Copies the entire directory, all its sub-directories and files. |
| `mv` old new | To rename an existing file or directory. `-i` option can also be used |
| `mv` f1 f2 f3 dir | To move a group of files to a directory. |
| `mv -v` old new | Display name of each file as it is moved. |
| `rm`file | Used to delete a file or group of files. `-i` option can also be used |
| `rm *` | To delete all the files in the directory. |
| `rm -r *` | Deletes all files and sub-directories |
| `rm -f *` | To forcibly remove even write-protected files |
| `ls` | Lists all files and subdirectories (blue colored) in sorted manner. |
| `ls`name | To check whether a file or directory exists. |
| `ls`name***** | Short-hand notation to list out filenames of a specific pattern. |
| `ls -a` | Lists all files including hidden files (files beginning with **.**) |
| `ls -x` dirname | To have specific listing of a directory. |
| `ls -R` | Recursive listing of all files in the subdirectories |
| `ls -l` | Long listing showing file access rights (read/write/execute-**rwx**for user/group/others-**ugo**). |
| `cmp`file1 file2 | Used to compare two files. Displays nothing if files are identical. |
| `wc`file | It produces a statistics of lines (**l**), words(**w**), and characters(**c**). |
| `chmod`perm file | Changes permission for the specified file. (`r=4, w=2, x=1`) `chmod 740 file` sets all rights for user, read only for groups and no rights for others |

## Output:

# GENERAL COMMANDS

```
[student@vecit ~]$ date
Mon Dec 15 10:12:47 AQTT 2014
 [student@vecit ~]$ date +%D
12/15/14
[student@vecit ~]$ date +%T
10:13:11
[student@vecit ~]$ date +%Y
2014
[student@vecit ~]$ date +%H
10
```



```
[sandhya@vecit ~]$ cal
    December 2014
Su Mo Tu We Th Fr Sa
    1  2  3  4  5  6
 7  8  9 10 11 12 13
14 15 16 17 18 19 20
21 22 23 24 25 26 27
28 29 30 31

[sandhya@vecit ~]$ cal 2014
                               2014

       January               February                 March
Su Mo Tu We Th Fr Sa   Su Mo Tu We Th Fr Sa   Su Mo Tu We Th Fr Sa
          1  2  3  4                      1                      1
 5  6  7  8  9 10 11    2  3  4  5  6  7  8    2  3  4  5  6  7  8
12 13 14 15 16 17 18    9 10 11 12 13 14 15    9 10 11 12 13 14 15
19 20 21 22 23 24 25   16 17 18 19 20 21 22   16 17 18 19 20 21 22
26 27 28 29 30 31      23 24 25 26 27 28      23 24 25 26 27 28 29
                                              30 31
        April                   May                   June
Su Mo Tu We Th Fr Sa   Su Mo Tu We Th Fr Sa   Su Mo Tu We Th Fr Sa
       1  2  3  4  5                1  2  3    1  2  3  4  5  6  7
 6  7  8  9 10 11 12    4  5  6  7  8  9 10    8  9 10 11 12 13 14
13 14 15 16 17 18 19   11 12 13 14 15 16 17   15 16 17 18 19 20 21
20 21 22 23 24 25 26   18 19 20 21 22 23 24   22 23 24 25 26 27 28
27 28 29 30            25 26 27 28 29 30 31   29 30

        July                 August                September
Su Mo Tu We Th Fr Sa   Su Mo Tu We Th Fr Sa   Su Mo Tu We Th Fr Sa
       1  2  3  4  5                   1  2       1  2  3  4  5  6
 6  7  8  9 10 11 12    3  4  5  6  7  8  9    7  8  9 10 11 12 13
13 14 15 16 17 18 19   10 11 12 13 14 15 16   14 15 16 17 18 19 20
20 21 22 23 24 25 26   17 18 19 20 21 22 23   21 22 23 24 25 26 27
27 28 29 30 31         24 25 26 27 28 29 30   28 29 30
                       31
       October               November               December
Su Mo Tu We Th Fr Sa   Su Mo Tu We Th Fr Sa   Su Mo Tu We Th Fr Sa
          1  2  3  4                      1       1  2  3  4  5  6
 5  6  7  8  9 10 11    2  3  4  5  6  7  8    7  8  9 10 11 12 13
12 13 14 15 16 17 18    9 10 11 12 13 14 15   14 15 16 17 18 19 20
19 20 21 22 23 24 25   16 17 18 19 20 21 22   21 22 23 24 25 26 27
26 27 28 29 30 31      23 24 25 26 27 28 29   28 29 30 31
                       30

[sandhya@vecit ~]$ cal 5 2014
      May 2014
Su Mo Tu We Th Fr Sa
             1  2  3
 4  5  6  7  8  9 10
11 12 13 14 15 16 17
18 19 20 21 22 23 24
25 26 27 28 29 30 31
```

```
[student@vecit ~]$ who
studentpts/1        Dec 15 10:05 (172.16.1.14)
```

```
[student@vecit ~]$ who am i
studentpts/1        Dec 15 10:05 (172.16.1.14)
[student@vecit ~]$ tty
/dev/pts/1
[student@vecit ~]$ uname
Linux
[student@vecit ~]$ echo "hello"
hello
[student@vecit ~]$ echo $HOME
/home/student
[student@vecit ~]$ bc
bc 1.06
Copyright 1991-1994, 1997, 1998, 2000 Free Software Foundation, Inc.
This is free software with ABSOLUTELY NO WARRANTY.
For details type `warranty'.
 [student@vecit ~]$ man lp
lp(1)                   Easy Software Products                  lp(1)
NAME
lp - print files
cancel - cancel jobs
SYNOPSIS
lp  [  -E  ]  [ -c ] [ -d destination ] [ -h server ] [ -m ] [ -n num-
      copies [ -o option ] [ -q priority ] [ -s ] [ -t title ] [ -H handling
      ] [ -P page-list ] [ file(s) ]
lp  [  -E  ]  [  -c ] [ -h server ] [ -i job-id ] [ -n num-copies [ -o
      option ] [ -q priority ] [ -t title ] [ -H handling ] [ -P page-list ]
      cancel  [  -a ] [ -h server ] [ -u username ] [ id ] [ destination ] [
      destination-id ]
DESCRIPTION
lpsubmits files for printing or alters a pending job. Use a filename of "-" to force printing from the
standard input.
cancelcancels existing print jobs. The -a option will remove all jobs
from the specified destination.


OPTIONS
      The following options are recognized by lp:
[student@vecit ~]$ history
1  ls
2  date
3  date +%D
4  date +%T
5  date +%Y
6  date +%H
7  cal
8  cal 2014
9  cal 5 2014
10  who
11  who am i
```

```
12  tty
13  uname
14  uname -r
15  uname -n
16  echo "hi"
17  echo $HOME
18  bc
19  manlp
20  history
21  PWD
22  pwd
23  mkdir san
24  mkdir san s
25  mkdir s1 s2
26  ls
27  cd s1
28  cd
29  cd /
30  cd..
31  cd . .
32  rmdir s
33  rmdir s1
34  ls
35  cd
36  ls
37  rmdir s1
38  ls
39  CAT>TEST
40  cat>test
41  cat test
42  cat>>test
43  cat test
44  cat test1
45  cat>test1
46  cp test test1
47  cat test1
48  exit
49  vi
50  vi swap.sh
51  sh swap
52  cc swap.sh
53  cc swap
54  sh swap.sh
55  vi swap.sh
56  sh swap.sh
57  vi swap.sh
58  sh swap.sh
59  vi temp.sh
60  sh temp.sh
```

```
61  vi temp.sh
62  sh temp.sh
63  vi temp.sh
64  sh temp.sh
65  vi temp.sh
66  sh temp.sh
67  exit
68  date
69  date + %D
70  date +%D
71  date +%T
72  date +% Y
73  exit
74  date
75  date +%D
76  date +%T
77  date +%Y
78  date +%H
79  cal
80  cal 2014
81  cal may 2014
82  cal 5 2014
83  who
84  who am i
85  tty
86  uname
87  echo "hello"
88  echo $HOME
89  bc
90  lp swap
91  manlp
92  history
```

## DIRECTORY COMMANDS

```
[student@vecit ~]$ pwd
/home/student
[student@vecit ~]$ mkdir san
 [student@vecit ~]$ mkdir s1 s2
[student@vecit ~]$ ls
s  s1  s2  san
[student@vecit ~]$ cd s1
[student@vecit s1]$ cd
[student@vecit ~]$ cd /
[student@vecit /]$ cd . .
 [student@vecit /]$ rmdir s1

 [student@vecit ~]$ ls
s  s2  san
[student@vecit ~]$
```

## FILE COMMANDS

```
[student@vecit ~]$ cat>test
hi welcome operating systems lab
[student@vecit ~]$ cat test
hi welcome operating systems lab
[student@vecit ~]$ cat>>test
fourth semester
[student@vecit ~]$ cat test
hi welcome operating systems lab fourth semester
[student@vecit ~]$ cat>test1
[student@vecit ~]$ cp test test1
[student@vecit ~]$ cat test1
hi welcome operating systems lab fourth semester
 [student@vecit ~]$ cp -i test test1
cp: overwrite `test1'? y
[student@vecit ~]$ cp -r test test1
[student@vecit ~]$ ls
s  s2  san  swap.sh  temp.sh  test  TEST  test1
[student@vecit ~]$ mv san san1
[student@vecit ~]$ ls
s  s2  san1  swap.sh  temp.sh  test  TEST  test1
[student@vecit ~]$ mv test test1 san1
[student@vecit ~]$ mv -v san1 sannew
`san1' -> `sannew'
[student@vecit ~]$ ls
s  s2sannew  swap.sh  temp.sh  TEST
[student@vecit ~]$ cmp test test1
cmp: test: No such file or directory
```

## Result

Thus the study and execution of Unix commands has been completed successfully.

## Viva Questions

1. What is the use of cat commands?
2. Define Operating Systems?
3. What is the use of filter/grep/pipe commands?
4. How is unix different from windows
5. What is unix?
6. What is the file structure of unix?
7. What is a kernel?
8. What is the difference between multi-user and multi-tasking?
9. Differentiate relative path from absolute path.
10. What are the differences among a system call, a library function, and a UNIX command?

**Ex. No: 1A**

## SIMPLE SHELL PROGRAMS

## AIM

To write simple shell scripts using shell programming fundamentals.

The activities of a shell are not restricted to command interpretation alone. The shell also has Rudimentary programming features. When a group of commands has to be executed regularly, they are stored in a file (with extension .**sh**). All such files are called shell scripts or shell programs. Shell programs run in interpretive mode.

The original UNIX came with the Bourne shell (**sh**) and it is universal even today. Then came a plethora of shells offering new features. Two of them, C shell (**csh**) and Korn shell (**ksh**) has been well accepted by the UNIX fraternity. Linux offers Bash shell (**bash**) as a superior alternative to Bourne shell.

### Preliminaries

1. Comments in shell script start with **#**. It can be placed anywhere in a line; the shell ignores contents to its right. Comments are recommended but not mandatory

2. Shell variables are loosely typed i.e. not declared. Their type depends on the value assigned. Variables when used in an expression or output must be prefixed by **$**.

3. The **read** statement is shell's internal tool for making scripts interactive.

4. Output is displayed using **echo** statement. Any text should be within quotes. Escape sequence should be used with **–e** option.

5. Commands are always enclosed with ` ` (back quotes).

6. Expressions are computed using the **expr** command. Arithmetic operators are + - * / %. Meta characters *** ( )** should be escaped with a \.

7. Multiple statements can be written in a single line separated by **;**

8. The shell scripts are executed using the **sh** command (shfilename).

## Swapping values of two variables

## Algorithm

```
Step 1 : Start
Step 2 : Read the values of a and b
Step 3 : Interchange the values of a and b using another variable t as follows:
t = a
a = b
b = t
Step 4 : Print a and b
Step 5 : Stop
```

## Program (swap.sh)

```
# Swapping values
```

```
echo -n "Enter value for A : "
read a
echo -n "Enter value for B : "
read b
t=$a
a=$b
b=$t
echo "Values after Swapping"
echo "A Value is $a"
echo "B Value is $b"
```

## Output

```
[student@vecit ~]$ sh swap.sh
Enter Value for A:5
Enter Value for B:6
Values after Swapping
A value is 6
B values is 5
[student@vecit ~]$
```

## Farenheit to Centigrade Conversion

### Algorithm

```
Step 1 : Start
Step 2 : Read fahrenheitvalue
Step 3 : Convert fahrenheittocentigradeusing the formulae: (fahrenheit – 32) × 5/9
Step 4 : Print centigrade
Step 5 : Stop
```

### Program

```
# Degree conversion
echo -n "Enter Fahrenheit : "
read f
c=`expr \( $f - 32 \) \* 5 / 9`
echo "Centigrade is : $c"
```

**Output**

```
[student@vecit ~]$ sh temp.sh
Enter Fahrenheit:4
Centrigrade is: -15
[student@vecit ~]$
```

## Result

Thus using programming basics, simple shell scripts were executed

**Ex no 1B**

## CONDITIONAL CONSTRUCTS

## Aim

To write shell scripts using decision-making constructs.

Shell supports decision-making using **`if`** statement. The**`if`** statement like its counterpart inprogramming languages has the following formats. The first construct executes thestatementswhen the condition is true. The second construct adds an optional **`else`** to thefirst one that has different set of statements to be executed depending on whether thecondition is true or false. The last one is an elif ladder, in which conditions are tested insequence, but only one set of statements is executed.

| | | |
|---|---|---|
| if [ condition ]<br>then<br>statements<br>fi | if [ condition ]<br>then<br>statements<br>else<br>statements<br>fi | if [condition ]<br>then<br>statements<br>elif [ condition ]<br>then<br>statements<br>.. .<br>else<br>statements<br>fi |

The set of relational and logical operators used in conditional expression is given below. The numeric comparison in the shell is confined to integer values only.

| **Operator** | **Description** |
|---|---|
| -eq | Equal to |
| -ne | Not equal to |
| -gt | Greater than |
| -ge | Greater than or equal to |
| -lt | Less than |
| -le | Less than or equal to |
| -a | Logical AND |
| -o | Logical OR |
| ! | Logical NOT |

## <u>Odd or even</u>

**Algorithm**

```
Step 1 : Start
Step 2 : Read number
Step 3 : If number divisible by 2 then
Print "Number is Even"
Step 3.1 : else
Print "Number is Odd"
Step 4 : Stop
```

**Program**

```
# Odd or even using if-else
echo -n "Enter a non-zero number : "
readnum
rem=`expr $num % 2`
if [ $rem -eq 0 ]
then
echo "$num is Even"
else
echo "$num is Odd"
fi
```

**Output**

```
[student@vecit ~]$ sh oddeven.sh
Enter a non-zero number : 12
12 is Even
```

## String comparison

**Algorithm**

```
Step 1 : Start
Step 2 : Read strings str1 and str2
Step 3 : If str1 = str2 then
Print "Strings are the same"
Step 3.1 : else
Print "Strings are distinct"
Step 4 : Stop
```

**Program**

```
echo -n "Enter the first string : "
read s1
echo -n "Enter the second string : "
read s2
if [ $s1 == $s2 ]
then
echo "Strings are the same"
else
echo "Strings are distinct"
fi
```

## Output

```
[student@vecit ~]$ sh strcomp.sh
Enter the first string :ece-a
Enter the second string : ECE-A
Strings are distinct
```

## Result

Thus using if statement scripts with conditional expressions were executed

**Ex No 1C**

### MULTI-WAY BRANCHING

## Aim

To write shell scripts using case construct to match patterns.

The `case` statement is used to compare a variables value against a set of constants (integer, character, string, range). If it matches a constant, then the set of statements followed after `)` is executed till a `;;` is encountered. The optional default block is indicated by *****. Multiple constants can be specified in a single pattern separated by **|**.

```
casevariablein
constant1)
statements ;;
constant2)
statements ;;
. . .
constantN)
statements ;;
*)
statements
esac
```

## Simple Calculator

**Algorithm**

```
Step 1 : Start
Step 2 : Read operands a and b
Step 3 : Display operation menu
Step 4 : Read option
Step 5 : If option = 1 then
Calculate c = a + b
Step 5.1 : else if option = 2 then
Calculate c = a – b
Step 5.2 : else if option = 3 then
Calculate c = a * b
Step 5.3 : else if option = 4 then
Calculate c = a / b
Step 5.4 : else if option = 5 then
Calculate c = a % b
```

Step 5.5 : else
Print "Invalid option"
Step 6 : Print c
Step 7 : Stop

**Program**

```
# Arithmetic operations--multiple statements in a block
echo -n "Enter the two numbers : "
read a b
echo " 1. Addition"
echo " 2. Subtraction"
echo " 3. Multiplication"
echo " 4. Division"
echo " 5. Modulo Division"
echo -n "Enter the option : "
read option
case $option in
1) c=`expr $a + $b`
echo "$a + $b = $c";;
2) c=`expr $a - $b`
echo "$a - $b = $c";;
3) c=`expr $a \* $b`
echo "$a * $b = $c";;
4) c=`expr $a / $b`
echo "$a / $b = $c";;
5) c=`expr $a % $b`
echo "$a % $b = $c";;
*) echo "Invalid Option"
esac
```

## Output

```
[student@vecit ~]$ shsimplecal.sh
Enter the two numbers : 2 4
1. Addition
2. Subtraction
3. Multiplication
4. Division
5. Modulo Division
Enter the option : 1
2 + 4 = 6
```

## Result

Thus using case statement, shell scripts were executed

**Ex No 1D**

## LOOPING

## Aim

To write shell scripts using looping statements.
Shell supports a set of loops such as **for**, **while** and **until** to execute a set of statements repeatedly. The body of the loop is contained between **do** and **done** statement.
The **for**loop doesn't test a condition, but uses a list instead.

```
forvariablein list
do
statements
done
```

The **while** loop executes the statements as long as the condition remains true.

```
while [ condition ]
do
statements
done
```

The **until** loop complements the while construct in the sense that the statements are executed as long as the condition remains false.

```
until [ condition ]
do
statements
done
```

## Armstrong Number

**Algorithm**

```
Step 1 : Start
Step 2 : Read number
Step 3 : Initialize 0 to sum and number to num
Step 4 : Extract lastdigitby computing number modulo 10
Step 5 : Cube the lastdigitand add it to sum
Step 6 : Divide number by 10
Step 7: Repeat steps 4–6 until number > 0
Step 8 : If sum = number then
Print “Armstrong number”
Step 8.1 : else
Print “Not an Armstrong number”
Step 9 : Stop
```

**Program (armstrong.sh)**

```
# Armstrong number using while loop
echo -n "Enter a number : "
read n
a=$n
s=0
while [ $n -gt 0 ]
```

```
do
r=`expr $n % 10`
s=`expr $s + \( $r \* $r \* $r \)`
n=`expr $n / 10`
done
if [ $a -eq $s ]
then
echo "Armstrong Number"
else
echo -n "Not an Armstrong number"
fi
```

## Output

```
[student@vecit ~]$ sh armstrong.sh
Enter a number : 370
Armstrong Number
```

## Result

Thus using loops, iterative scripts were executed

## Viva Questions

1. What is Shell?
2. What are some common shells and what are their indicators?
3. Briefly describe the Shell’s responsibilities
4. What are shell variables?
5. What is Bash Shell?
6. Differentiate cat command from more command.
7. What does this command do? cat food 1 > kitty
8. What’s the conditional statement in shell scripting?
9. How do you do number comparison in shell scripts?
10. How do you define a function in a shell script?

**Ex No: 3A**

# IMPLEMENTATION OF ROUND ROBIN SCHEDULING ALGORITHM

## Aim

To write a C program to implement Round Robin scheduling algorithm.

## Algorithm:

Step 1: Start the program.
Step 2: Get the input process and their burst time.
Step 3: Sort the processes based on priority.
Step 4: Compute the waiting time and turnaround time for each process.
Step 5: Calculate the average waiting time and average turnaround time.
Step 6: Print the details about all the processes.
Step 7: Stop the program.

## Program:

```
#include<stdio.h>
#include<conio.h>
voidmain()
{
intct=0,y[30],j=0,bt[10],cwt=0;
inttq,i,max=0,n,wt[10],t[10],at[10],tt[10],b[10];
float a=0.0,s=0.0;
char p[10][10];
clrscr();
printf("\n enter the no of process:");
scanf("%d",&n);
printf("\nenter the time quantum");
scanf("%d",&tq);
printf("\nenter the process name,bursttime,arrival time");
for(i=0;i<n;i++)
{
scanf("%s",p[i]);
scanf("%d",&bt[i]);
scanf("%d",&at[i]);
wt[i]=t[i]=0;
b[i]=bt[i];
}
printf("\n\t\tGANTT CHART");
printf("\n------------------------------------------------------\n");
for(i=0;i<n;i++)
{
if(max<bt[i])
max=bt[i];
}
while(max!=0)
```

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

if(bt[i]>0)
{
if(ct==0)
wt[i]=wt[i]+cwt;
else
wt[i]=wt[i]+(cwt-t[i]);
}
if(bt[i]==0)
cwt=cwt+0;
else if(bt[i]==max)
{
if(bt[i]>tq)
{
cwt=cwt+tq;
bt[i]=bt[i]-tq;
max=max-tq;
}
else
{
cwt=cwt+bt[i];
bt[i]=0;
max=0;
}
printf("|\t%s",p[i]);
y[j]=cwt;
j++;
}
else if(bt[i]<tq)
{
cwt=cwt+bt[i];
bt[i]=0;
printf("|\t%s",p[i]);
y[j]=cwt;
j++;
}
else if(bt[i]>tq)
{
cwt=cwt+tq;
bt[i]=bt[i]-tq;
printf("|\t%s",p[i]);
y[j]=cwt;
j++;
}
else if(bt[i]==tq)
{
cwt=cwt+bt[i];
printf("|\t%s",p[i]);
bt[i]=0;
y[j]=cwt;
j++;
}
t[i]=cwt;
}
ct=ct+1;
}
for(i=0;i<n;i++)
{
wt[i]=wt[i]-at[i];
a=a+wt[i];
tt[i]=wt[i]+b[i];
s=s+tt[i];
}
a=a/n;
s=s/n;
printf("\n------------------------------------------------------");
printf("\n0");
for(i=0;i<j;i++)
printf("\t%d",y[i]);
printf("\n");
printf("\n------------------------------------------------------");
printf("\n\t\t ROUND ROBIN\n");
printf("\n Process Burst-time Arrival-time Waiting-time Turnaround-time\n");
for(i=0;i<n;i++)
printf("\n\n %d%s \t %d\t\t %d \t\t %d\t\t %d",i+1,p[i],b[i],at[i],wt[i],tt[i]);
printf("\n\nAvg waiting time=%f",a);
printf("\n\nAvgturn around time=%f",s);
getch();
}
```

## Output:

```
enter the no of process:3
enter the time quantum2
enter the process name,bursttime,arrival time
p1 2 0
p2 3 1
p3 4 2
           GANTT CHART
----------------------------------------------------
|     p1|    p2|    p3|    p2|    p3
-----------------------------------------------------
0      2      4      6      7      9
-----------------------------------------------------
            ROUND ROBIN
 Process Burst-time Arrival-time Waiting-time Turnaround-time
 1p1           2            0              0            2
 2p2           3            1              3            5
 3p3            4            2              3            5
Avg Waiting Time=2.000000
Avg Turnaround Time=4.000000
```

## Result

The Round Robin scheduling algorithm has been implemented in C.

**Ex No: 3B**

## IMPLEMENTATION OF SJF SCHEDULING ALGORITHM

## Aim

To write a C program to implement shortest job first (non-pre-emptive) scheduling algorithm.

## Description:

Assume the next burst time of each process is known. SJF selects process which has the shortest burst time. This is an Optimal algorithm because it has the shortest average waiting time, however it is impossible to know in advance. OS knows the past burst times - make a prediction using an average. It can be either nonpreemptive or preemptive scheduling.. It processes shortest-remaining-time-first. The process interrupts running process if a new process enters the queue. The new process must have shorter burst than remaining time.

## Algorithm:

Step 1: Start the program.
Step 2: Get the input process and their burst time.
Step 3: Sort the processes based on burst time.
Step 4: Compute the waiting time and turnaround time for each process.
Step 5: Calculate the average waiting time and average turnaround time.
Step 6: Print the details about all the processes.
Step 7: Stop the program.

## Program:

```
#include<stdio.h>
#include<conio.h>
voidmain()
{
int i,j,n,bt[30],at[30],st[30],ft[30],wat[30],wt[30],temp,temp1,tot,tt[30];
floatawt,att;
int p[15];
clrscr();
wat[1]=0;
printf("ENTER THE NO.OF PROCESS");
scanf("%d",&n);
printf("\nENTER THE PROCESS NUMBER,BURST TIME AND ARRIVAL TIME");
for(i=1;i<=n;i++)
{
scanf("%d\t %d\t %d",&p[i],&bt[i],&at[i]);
}
printf("\nPROCESS\tBURSTTIME\tARRIVALTIME");
for(i=1;i<=n;i++)
{
printf("\np%d\t%d\t\t%d",p[i],bt[i],at[i]);
}
for(i=1;i<=n;i++)
```

```
{
for(j=i+1;j<=n;j++)
{
if(bt[i]>bt[j])
{
temp=bt[i];
bt[i]=bt[j];
bt[j]=temp;
temp1=p[i];
p[i]=p[j];
p[j]=temp1;
}
}
if(i==1)
{
st[1]=0;
ft[1]=bt[1];
wt[1]=0;
}
else
{
st[i]=ft[i-1];
ft[i]=st[i]+bt[i];
wt[i]=st[i];
}
}
printf("\n\n\t\t\tGANTT CHART\n");
printf("\n--------------------------------------------------\n");
for(i=1;i<=n;i++)
printf("|\tp%d\t",p[i]);
printf("|\t\n");
printf("\n---------------------------------------------------\n");
printf("\n");
for(i=1;i<=n;i++)
printf("%d \t\t",wt[i]);
printf("%d",wt[n]+bt[n]);
printf("\n----------------------------------------------------\n");
for(i=2;i<=n;i++)
wat[i]=wt[i]-at[i];
for(i=1;i<=n;i++)
tt[i]=wat[i]+bt[i];
printf("\nPROCESS\tBURSTTIME\tARRIVALTIME\tWAITINGTIME\tTURNAROUNDTIM
E\n");
for(i=1;i<=n;i++)
{
printf("\np%d %5d %15d %15d %15d",p[i],bt[i],at[i],wat[i],tt[i]);
}
for(i=1,tot=0;i<=n;i++)
tot+=wt[i];
awt=(float)tot/n;
printf("\n\n\n AVERAGE WAITING TIME=%f",awt);
for(i=1,tot=0;i<=n;i++)
tot+=tt[i];
att=(float)tot/n;
printf("\n\n AVERAGE TURNAROUND TIME=%f",att);
getch();
}
```

## Output:

```
enter the no.of process3
enter the process number,burst time and arrival time1 8 1
2 5 1
3 3 1
PROCESS BURSTTIME      ARRIVALTIME
p1              8                1
p2              5                1
p3              3                1
                GANTT CHART
------------------------------------------
|     p3     |     p2     |     p1     |
-------------------------------------------
0           3           8           16
--------------------------------------------
PROCESS  BURSTTIME   ARRIVALTIME   WAITINGTIME   TURNAROUNDTIME
p3                3              1                  0                    2
p2                5              1                  2                    6
p1                8              1                  7                   14
AVERAGE WAITING TIME=3.666667
AVERAGE TURNAROUND TIME=7.333333
```

## Result

The SJF scheduling algorithm has been implemented in C.

**Ex No: 3C**

### 3 C. IMPLEMENTATION OF FCFS SCHEDULING ALGORITHM

## Aim

To write a C program to implement First Come First Serve scheduling algorithm.

## Desription:

This is a non-preemptive technique.A single queue of ready processes is maintained, and the dispatcher always picks the first one.This method does not emphasises throughput, since long processes are allowed to monopoliseCPU.The response time with FCFS can be high (with respect to execution time), especially if there is a high variance in process execution times.

This method penalises short processes following long ones, though no starvation is possible.

Jobs are processed in the order in which they arrive at a machine or work center

## Algorithm:

Step 1: Start the program.
Step 2: Get the input process and their burst time.
Step 3: Sort the processes based on order in which it requests CPU.
Step 4: Compute the waiting time and turnaround time for each process.
Step 5: Calculate the average waiting time and average turnaround time.
Step 6: Print the details about all the processes.
Step 7: Stop the program.

## Program:

```
#include<stdio.h>
#include<conio.h>
voidmain()
{
intbt[50],wt[80],at[80],wat[30],ft[80],tat[80];
inti,n;
floatawt,att,sum=0,sum1=0;
char p[10][5];
clrscr();
printf("\nenter the number of process....");
scanf("%d",&n);
printf("\nEnter the process name  and burst-time:");
for(i=0;i<n;i++)
scanf("%s%d",p[i],&bt[i]);
printf("\nEnter the arrival-time:");
for(i=0;i<n;i++)
scanf("%d",&at[i]);
wt[0]=0;
for(i=1;i<=n;i++)
wt[i]=wt[i-1]+bt[i-1];

ft[0]=bt[0];
for(i=1;i<=n;i++)
ft[i]=ft[i-1]+bt[i];
printf("\n\n\t\t\tGANTT CHART\n");
printf("\n-------------------------------------------------------------\n");
for(i=0;i<n;i++)
printf("|\t%s\t",p[i]);
printf("|\t\n");
printf("\n-------------------------------------------------------------\n");
printf("\n");
for(i=0;i<n;i++)
printf("%d\t\t",wt[i]);
printf("%d",wt[n]+bt[n]);
printf("\n-------------------------------------------------------------\n");
printf("\n");
for(i=0;i<n;i++)
wat[i]=wt[i]-at[i];
for(i=0;i<n;i++)
tat[i]=wat[i]+bt[i];
printf("\n FIRST COME FIRST SERVE\n");
printf("\n Process Burst-time Arrival-time Waiting-time Finish-time Turnaround-time\n");
for(i=0;i<n;i++)
printf("\n\n %d%s \t %d\t\t %d \t\t %d\t\t %d \t\t %d",i+1,p[i],bt[i],at[i],wat[i],ft[i],tat[i]);
for(i=0;i<n;i++)
sum=sum+wat[i];
awt=sum/n;
for(i=0;i<n;i++)
sum1=sum1+bt[i]+wt[i];
att=sum1/n;
printf("\n\nAverage waiting time:%f",awt);
printf("\n\nAverage turnaround time:%f",att);
getch();
}
```

## Output:

```
enter the number of process....3
Enter the process name  and burst-time:p1 2
p2 3
p3 4
Enter the arrival-time:0  1  2
```

```
                GANTT CHART
---------------------------------------------------------
|    p1    |    p2    |    p3    |
---------------------------------------------------------
0          2          5          9
---------------------------------------------------------
 FIRST COME FIRST SERVE
 Process Burst-time Arrival-time Waiting-time Finish-time Turnaround-time
 1p1          2          0          0                2          2
 2p2          3          1          1                5          4
 3p3          4          2          3                9          7
Average waiting time:1.333333
Average turnaround time:5.333333
```

## Result:

The FCFS scheduling algorithm has been implemented in C.

**Ex No: 3D**

### IMPLEMENTATION OF PRIORITYSCHEDULINGALGORITHM

## Aim

To write a C program to implement Priority Scheduling algorithm.

## Algorithm:

Step 1: Start the program.<br>
Step 2: Get the input process and their burst time.<br>
Step 3: Sort the processes based on priority.<br>
Step 4: Compute the waiting time and turnaround time for each process.<br>
Step 5: Calculate the average waiting time and average turnaround time.<br>
Step 6: Print the details about all the processes.<br>
Step 7: Stop the program.

## Program:

```
#include<stdio.h>
#include<string.h>
#include<conio.h>
voidmain()
{
intbt[30],pr[30],np;
intwt[30],tat[30],wat[30],at[30],ft[30];
inti,j,x,z,t;
float sum1=0,sum=0,awt,att;
char p[5][9],y[9];
clrscr();
printf("\nenter the number of process");
```

```
scanf("%d",&np);
printf("\nEnter the process,burst-time and priority:");
for(i=0;i<np;i++)
scanf("%s%d%d",p[i],&bt[i],&pr[i]);
printf("\nEnter the arrival-time:");
for(i=0;i<np;i++)
scanf("%d",&at[i]);
for(i=0;i<np;i++)
for(j=i+1;j<np;j++)
{
if(pr[i]>pr[j])
{
x=pr[j];
pr[j]=pr[i];
pr[i]=x;
strcpy(y,p[j]);
strcpy(p[j],p[i]);
strcpy(p[i],y);
z=bt[j];
bt[j]=bt[i];
bt[i]=z;

}
}
wt[0]=0;
for(i=1;i<=np;i++)
wt[i]=wt[i-1]+bt[i-1];
ft[0]=bt[0];
for(i=1;i<np;i++)
ft[i]=ft[i-1]+bt[i];
printf("\n\n\t\tGANTT CHART\n");
printf("\n----------------------------------------------------------------\n");
for(i=0;i<np;i++)
printf("|\t%s\t",p[i]);
printf("|\t\n");
printf("\n--------------------------------------------------------------------------\n");
printf("\n");
for(i=0;i<=np;i++)
printf("%d\t\t",wt[i]);
printf("\n--------------------------------------------------------------------------\n");
printf("\n");
for(i=0;i<np;i++)
wat[i]=wt[i]-at[i];
for(i=0;i<np;i++)
tat[i]=wat[i]+bt[i];
printf("\nPRIORITY SCHEDULING:\n");
printf("\nProcess Priority Burst-time Arrival-time Waiting-time Turnaround-time");
for(i=0;i<np;i++)
printf("\n\n%d%s\t%d\t\t%d\t\t%d\t%d\t\t%d",i+1,p[i],pr[i],bt[i],at[i],wt[i],tat[i]);
for(i=0;i<np;i++)
sum=sum+wat[i];
awt=sum/np;
for(i=0;i<np;i++)
sum1=sum1+tat[i];
att=sum1/np;
printf("\n\nAverage waiting time:%f",awt);
printf("\n\nAverageturn around time is:%f",att);
getch();
}
```

## Output:

```
Enter the number of process3
Enter the process, burst-time and priority:
p1 3 3
p2 4 2
p3 5 1
Enter the arrival-time: 0 1 2

            GANTT CHART
--------------------------------------------------
|      p3     |      p2     |      p1     |
----------------------------------------------------------
0            5             9            12
----------------------------------------------------------
PRIORITY SCHEDULING:
Process Priority Burst-time Arrival-time Waiting-time Turnaround-time

1p3           1          5          0          0          0

2p2           2        4          1          5          3

3p1           3          3          2        9          5

Average waiting time: 3.666667
Average turnaround time is: 2.666667
```

## Result

The Priority scheduling algorithm has been implemented in C.

## Viva Questions

1. Define process.
2. What is meant by burst time, waiting time and turnaround time?

3. What are the various scheduling algorithms?
4. Explain FCFS scheduling.
5. Explain SJF scheduling.
6. Explain Priority scheduling.
7. Can priority scheduling cause starvation?
8. Explain Round Robin scheduling.
9. What is meant by response time and slice time?
10. What is pre-emptive and non-preemptive scheduling?

**Ex No: 4**

# PRODUCER CONSUMER PROBLEM USING SEMAPHORES

## Aim:

To write a C program to implement producer consumer problem using semaphore

## Algorithm:

**Step 1:** Declarethe buffer size variable.
**Step 2:** Initialize empty, full and the value of mutex.
**Step 3:** For case 1 , produce the item till the buffer is full after performing the wait operation of variables empty and mutex.
**Step 4:** Then perform signal of full.
**Step 5:** For case 2, consume the item till the buffer is empty. Perform the wait and signal operation..
**Step 6:** print the contents of the buffer**.**

## Program:

```
#include<stdio.h>
#include<string.h>
#define SIZE 3
struct process
{
char a[10];
}buffer[SIZE];
intmutex=1,full=0,empty=SIZE,f=0;
int main()
{
//intmutex=1,full=0,empty=SIZE,f=0;
intch,i;
printf("\tProdecer Consumer Problem:\n");
while(1)
{
printf("\n The choices are\n");
printf("1.Producer Routine\n2.Consumer Routine\n3.Buffer Contents\n4.Exit\n");
printf("Enter your Choice:");
scanf("%d",&ch);
switch(ch)
{
case 1:
empty=wait(empty);
mutex=wait(mutex);
if(f==0)
{
printf("\nEnter the item to be added:\n");
scanf("%s",&buffer[full]);
full=signal(full);
printf("\nItem Produced Successfully:\n");
}
else
{
printf("\nBuffer is full\n");
f=0;
}
mutex=signal(mutex);
break;
case 2:
full=wait(full);
mutex=wait(mutex);
if(f==0)
{
printf("\nOne Item is Consumed:\n");
printf("\nConsumed item is: %s\n",buffer[0].a);
for(i=0;i<SIZE;i++)
strcpy(buffer[i].a,buffer[i+1].a);
empty=signal(empty);
}
else
{
printf("\nBuffer is empty\n");
f=0;
}
mutex=signal(mutex);
break;
case 3:
if(full!=0)
{
for(i=0;i<full;i++)
printf("\n%s\n",buffer[i].a);
}
else
printf("\nBuffer is empty\n");
break;
case 4:
exit(0);
default:
```

```
printf("Enter Correct Option");
break;
}
}
}
int wait(int s)
{
if(s==0)
f=1;
else
s--;
return s;
}
int signal(int s)
{
s++;
return s;
}
```

**Output:**

```
The choices are
1.Producer Routine
2.Consumer Routine
3.Buffer Contents
4.Exit
Enter your Choice:1
Enter the item to be added:
1
Item Produced Successfully:
The choices are
1.Producer Routine
2.Consumer Routine
3.Buffer Contents
4.Exit
Enter your Choice:1
Enter the item to be added:
2
Item Produced Successfully:
 The choices are
1.Producer Routine
2.Consumer Routine
3.Buffer Contents
4.Exit
Enter your Choice:1
Enter the item to be added:3
Item Produced Successfully:
 The choices are
1.Producer Routine
2.Consumer Routine
```

```
3.Buffer Contents
4.Exit
Enter your Choice:1
Buffer is full
 The choices are
1.Producer Routine
2.Consumer Routine
3.Buffer Contents
4.Exit
Enter your Choice:2
One Item is Consumed:
Consumed item is: 1
 The choices are
1.Producer Routine
2.Consumer Routine
3.Buffer Contents
4.Exit
Enter your Choice:
```

## Result

Thus the producer consumer problem using semaphores has been implemented in C.

## Viva Questions

1. What is a semaphore?
2. What is bounded-buffer problem?
3. What is readers-writers problem?
4. What is dining philosophers' problem?
5. What is process synchronization?
6. What is critical section problem?
7. What are the two operations of a semaphore? Explain.
8. What is deadlock and starvation?
9. What do you mean by monitors?
10. What is the advantage of monitors over semaphores?

# ExNo:5 BANKERS ALGORITHM FOR DEADLOCK AVOIDANCE

## Aim:

To write a program to implement bankers algorithm for deadlock avoidance.

## Algorithm:

1. Start the program.
2. Get the number of process, resource, allocation matrix, Maximum matrix and available matix.
3. Calcualte need matrix using Maximum matrix and allocation matrix i.e., NEED[i,j]=MAX[i,j]-ALLOC[i,j]. Also initialize work matrix i.e., WORK[j]=AVAIL[j].

4. Now find safety sequence of the system using work matrix,need matrix.
5. Now compare NEED and WORK matrix, if NEED[i,j]<=WORK[j] then

   Execute the corresponding process also calculate new work matrix i.e.,

   WORK[j] =WORK[j]+ALLOC[i,j].

6. If condition doesn't satisfy, move to next process and repeat Step 5, until completion of all processes and print the safety sequence.
7. If any process request for resource, get the process id and request matrix from the user.
8. Check the following conditions for the respective process using Request matrix,Need matrix and Available matrix i.e., REQ[j]<=NEED[k,j] and

   REQ[j]<=AVAIL[j].

9. If the above condition satisfies, request can be granted and proceed next stepotherwise display error as "Request cannot be granted".
10. Now calculate new Available matrix,Allocation matrix,Need matrix and

Work matrix i.e.,AVAIL[j]=AVAIL[j]-REQ[j],

WORK[j]=AVAIL[j],ALLOC[k,j]=ALLOC[k,j]+REQ[j],

NEED[k,j]=NEED[k,j]-REQ[j].

11. To find safety sequence of the system, repeat Step 5 and Step 6 for all processes.
12. Then print the safety sequence of execution of processes.
13. Stop the program.

**Program:**

```
#include<stdio.h>
#include<stdlib.h>
#include<conio.h>
void main()
{
int alloc[20][20],max[20][20],avail[20],need[20][20],work[20]={0};
int newavail[20],req[20]={0},check=0,check2=0,cond,p;
int i=0,j=0,m=0,n=0,x=0,c[20]={0},count,count2,a[20],b;
int x2=0,c2[20];
clrscr();
printf("Enter the no. of resources\n");
scanf("%d",&m);
printf("Enter the no. of process");
scanf("%d",&n);
printf("\n Enter the resources for available\n");
for(j=1;j<=m;j++)
{
printf("Enter the %d resources of avail",j);
scanf("%d", &avail[j]);
work[j]=avail[j];
}
for(i=1;i<=n;i++)
```

```
{
for(j=1;j<=m;j++)
{
printf("Enter the %d resources of %d alloc",j,i);
scanf("%d", &alloc[i][j]);
}
for(j=1;j<=m;j++)
{
printf("\n Enter the %d resource of %d max",j,i);
scanf("%d",&max[i][j]);
need[i][j]=max[i][j]-alloc[i][j];
}
}
printf("\n Allocation      max      need\n");
for(i=1;i<=n;i++)
{
for(j=1;j<=m;j++)
printf("%2d",alloc[i][j]);
printf("\t");
for(j=1;j<=m;j++)
printf("%2d",max[i][j]);
printf("\t");
for(j=1;j<=m;j++)
```

```
printf("%2d",need[i][j]);

printf("\n");

}

printf("\n Process executes in this order\n");

do{

for(i=1;i<=n;i++)

{

count=0;

if(c[i]!=i+1)

{

for(j=1;j<=m;j++)

{

if(need[i][j]<=work[j])

count = count+1;

}

if(count == m)

{

printf("p%d\t",i);

c[i]=i+1;

x = x+1;

for(j=1;j<=n;j++)

work[j]=work[j]+alloc[i][j];

}
}
}
check = check +1;
}
while(x<n && check <=n);
if(x==n)
printf("\n system is in saftey\n");
else
printf("\n System is not in saftey");
printf("\n Checking the bankers algorithm after the request");
printf("\n Enter the request process number");
scanf("%d",&p);
printf("\n Enter the values");
for(j=1;j<=m;j++)
{
scanf("%d",&req[j]);
}
for(j=1;j<=m;j++)
{
if(req[j]<=avail[j]&& req[j]<=need[p][j])
cond=cond+1;
}
if(cond != m)
```

```
{

for(j=1;j<=m;j++)

{

alloc[p][j]=alloc[p][j]+req[j];

avail[j]=avail[j]-req[j];

need[p][j]=need[p][j]-req[j];

}

}

else

{

printf("req is not satisfied");

exit(0);

}

printf("\n Execution of process after request");


do

{

for(i=1;i<=n;i++)

{

count2=0;

if(c2[i]!=i+1)

{

for(j=1;j<=m;j++)
{
if(need[i][j]<=avail[j])
count2 = count2+1;
}
if(count2 == m)
{
printf("p%d\t",i);
c2[i]=i+1;
x2 = x2+1;
for(j=1;j<=n;j++)
avail[j]=avail[j]+alloc[i][j];
}
}
}
check2 = check2 +1;
}
while(x2<n && check2 <=n);
if(x2==n)
printf("\n system is in saftey\n");
else
printf("\n System is not in saftey");
getch();
```

```
}
```

## Output

```
Enter the no. of resources
3
Enter the no. of process3
Enter the resources for available
Enter the 1 resources of avail1
Enter the 2 resources of avail2
Enter the 3 resources of Avail3
Enter the 1 resources of 1 alloc3
Enter the 2 resources of 1 alloc2
Enter the 3 resources of 1 alloc1
 Enter the 1 resource of 1 max1
 Enter the 2 resource of 1 max2
 Enter the 3 resource of 1 max3
Enter the 1 resources of 2 alloc2
Enter the 2 resources of 2 alloc2
Enter the 3 resources of 2 alloc2
 Enter the 1 resource of 2 max3
 Enter the 2 resource of 2 max3
 Enter the 3 resource of 2 max3
Enter the 1 resources of 3 alloc2
Enter the 2 resources of 3 alloc2
Enter the 3 resources of 3 alloc2
 Enter the 1 resource of 3 max1
 Enter the 2 resource of 3 max2
 Enter the 3 resource of 3 max3
 Allocation      max      need
 3 2 1               1 2 3     -2 0 2
 2 2 2                3 3 3      1 1 1
 2 2 2               1 2 3      -1 0 1
 Process executes in this order
```

```
p1      p2      p3
 system is in saftey
 Checking the bankers algorithm after the request
 Enter the request process number2
 Enter the values1
1
1
execution after the request
p1     p2      p3
the system is in safe state.
```

## Result:

The program for banker’s algorithm for deadlock avoidance was implemented and hence verified.

## Viva Questions:

1. Explain Bankers algorithm?
2. What is system model?
3. What is meant by deadlock?
4. What are conditions under which a deadlock situation may arise?
5. What are the methods for Handling Deadlocks?
6. What  is mutual exclusion?
7. What is dead lock avoidance?
8. What are the dead lock avoidance methods?
9. What is meant by starvation?
10. When a system is said to be in safe state?

# Ex No: 6 IMPLEMENTATION OF DEADLOCK DETECTION

## Aim:

To write a program to implement Deadlock detection algorithm.

## Algorithm:

**Step 1:** Start the program.

**Step 2:** Get the values of resources and processes.

**Step 3:** Get the allocation and request matrix value.

**Step 4:** Get the available instances for each resources

**Step 5:** Check whether its possible to allocate using below condition.

**Step 6:** If Need<=Work update work as work=work +allocation

**Step 7:** Else proceed with next process.

**Step 8:** If it is possible to allocate then the system is in safe state.

**Step 9:** Else system is not in safe state.

**Step 10:** Stop the program.

## Program:

```
#include <stdio.h>
main()
{
 int found,flag,l,p[5][6],tp,tr,c[5][6],i,j,k=1,m[6],r[6],a[6],temp[6],sum=0;
  printf("Enter total no of processes");
 scanf("%d",&tp);
 printf("Enter total no of resources");
 scanf("%d",&tr);
 printf("Enter claim (Max. Need) matrix\n");
 for(i=1;i<=tp;i++)
 {
  printf("process %d:\n",i);
  for(j=1;j<=tr;j++)
  scanf("%d",&c[i][j]);
 }
 printf("Enter allocation matrix\n");
 for(i=1;i<=tp;i++)
```

```
{
 printf("process %d:\n",i);
 for(j=1;j<=tr;j++)
 scanf("%d",&p[i][j]);
}
printf("Enter resource vector (Total resources):\n");
for(i=1;i<=tr;i++)
{
 scanf("%d",&r[i]);
}
printf("Enter availability vector (available resources):\n");
for(i=1;i<=tr;i++)
{
 scanf("%d",&a[i]);
 temp[i]=a[i];
}
for(i=1;i<=tp;i++)
{
 sum=0;
 for(j=1;j<=tr;j++)
 {
  sum+=p[i][j];
 }
 if(sum==0)
 {
  m[k]=i;
  k++;
 }
}
for(i=1;i<=tp;i++)
{
 for(l=1;l<k;l++)
 if(i!=m[l])
 {
  flag=1;
  for(j=1;j<=tr;j++)
  if(c[i][j]<temp[j])
  {
   flag=0;
   break;
  }
 }
 if(flag==1)
 {
  m[k]=i;
  k++;
  for(j=1;j<=tr;j++)
  temp[j]+=p[i][j];
 }
}
printf("deadlock causing processes are:");
for(j=1;j<=tp;j++)
{
 found=0;
 for(i=1;i<k;i++)
 {
  if(j==m[i])
  found=1;
 }
 if(found==0)
 printf("%d\t",j);
}
}
```

## Output :

```
Enter total no. of processes 4
Enter total no. of resources 5
Enter claim (Max. Need) matrix :0 1 0 0 1
0 0 1 0 1
```

```
0 0 0 0 1
1 0 1 0 1
Enter allocation matrix :1 0 1 1 0
1 1 0 0 0
0 0 0 1 0
0 0 0 0 0
Enter resource vector (Total resources) :
2 1 1 2 1
Enter availability vector (available resources) :
0 0 0 0 1
deadlock causing processes are : 2 3
```

## Result:

The program for deadlock detection algorithm was implemented and hence verified

## Viva Questions:

1. What is deadlock, starvation? Explain their difference.
2. How can we detect deadlocks?
3. What is deadlock prevention? Explain its methods.
4. What is meant by finite state?
5. What is resource allocation graph?
6. Define Request Edge and Assignment Edge.
7. What are the different types of deadlock detection  used?
8. Explain How deadlocks are  corrected.
9. List advantages of Deadlock Prevention.
10. List advantages and disadvantages of deadlock detection

# Ex No: 7. THREADING AND SYNCHRONIZATION APPLICATIONS

## Aim:

To write a program to implement the application of threading and synchronization.

## Algorithm:

**Step 1:** Start the process

**Step 2:** Initialize mutex lock ,thread id and required other variables

**Step 3:** Create POSIX threads using pthread_create

**Step 4:** Define thread task by creating new function.

**Step 5:** Synchronize threads using mutex lock and unlock variables

**Step 6:** Using pthread_join allow threads to wait until parent process completes

**Step 7:** Destroy the synchronization variable mutex using pthread_mutex_destroy

**Step 8:** Stop the process

## Program

**//Threading Application Program**

```
#include <pthread.h>
#include <stdio.h>
/* this function is run by the second thread */
void *inc_x(void *x_void_ptr)
{
/* increment x to 100 */
int *x_ptr = (int *)x_void_ptr;
while(++(*x_ptr) < 100);
printf("x increment finished\n");
return NULL;
}
int main()
{
int x = 0, y = 0;
/* show the initial values of x and y */
printf("x: %d, y: %d\n", x, y);
/* this variable is our reference to the second thread */
pthread_t inc_x_thread;
/* create a second thread which executes inc_x(&x) */
if(pthread_create(&inc_x_thread, NULL, inc_x, &x)) {
fprintf(stderr, "Error creating thread\n");
return 1;
}
/* increment y to 100 in the first thread */
while(++y < 100);
printf("y increment finished\n");
/* wait for the second thread to finish */
if(pthread_join(inc_x_thread, NULL)) {
fprintf(stderr, "Error joining thread\n");
return 2;
}
/* show the results - x is now 100 thanks to the second thread */
printf("x: %d, y: %d\n", x, y);
return 0;
}
```

## Output

```
[student@vecit ~]$ gcc final.c –o final -lthread
[student@vecit ~]$  ./a.out
x: 0, y: 0
y increment finished
x increment finished
x: 100, y: 100
```

**//Synchoronization Application Program**

```
#include<stdio.h>
#include<string.h>
#include<pthread.h>
#include<stdlib.h>
#include<unistd.h>
pthread_t tid[2];
```

```
int counter;
pthread_mutex_t lock;
void* doSomeThing(void *arg)
{
    pthread_mutex_lock(&lock);
    unsigned long i = 0;
    counter += 1;
    printf("\n Job %d started\n", counter);
    for(i=0; i<(0xFFFFFFFF);i++);
    printf("\n Job %d finished\n", counter);
    pthread_mutex_unlock(&lock);
    return NULL;
}
int main(void)
{
    int i = 0;
    int err;
    if (pthread_mutex_init(&lock, NULL) != 0)
    {
        printf("\n mutex init failed\n");
        return 1;
    }
    while(i < 2)
    {
        err = pthread_create(&(tid[i]), NULL, &doSomeThing, NULL);
        if (err != 0)
            printf("\ncan't create thread :[%s]", strerror(err));
        i++;
    }
    pthread_join(tid[0], NULL);
    pthread_join(tid[1], NULL);
    pthread_mutex_destroy(&lock);
    return 0;
}
```

## Output

```
[student@vecit ~]$ synthread.c -o synthread -pthread
[student@vecit ~]$./a.out

 Job 1 started
 Job 1 finished
 Job 2 started
 Job 2 finished
```

## Result:

The program for threading and synchronizationwas implemented and hence verified.

## Viva Questions:

1. Define threads?
2. List the types of threads
3. What is multithreading?
4. What is posix thread?
5. How thread is different from process.
6. Compare User Threads and Kernel Threads.
7. Define synchronization.
8. How threads can be used for synchronization.
9. Define Thread Cancellation & Target Thread.
10. What are the different ways in which a Thread can be cancelled?

# Ex No: 8 PAGING TECHNIQUE OF MEMORY MANAGEMENT

## Aim:

To implement the Memory management using Paging technique.

## Algorithm

1. Start the process
2. Declare the size and data variables
3. Get the number of processes to be inserted
4. Get the value
5. Start and identify the process with process id
6. Make the variables and arguments to be a global while in communication
7. Write a separate routine for creating memory delete memory in separate region
8. Give permission that a process can kill paging
9. Display the values
10. Stop the process

## Program

```
#include<stdio.h>
int main()
{
int p[50],f[20],m,ps,n,i,pg,tf,off,pg1,off1,pa;
printf("\n Enter the memory size:");
scanf("%d",&m);
printf("\n Enter the process size:");
scanf("%d",&ps);
printf("\n Enter the page size:");
scanf("%d",&pg);
n=ps/pg;
tf=m/pg;
for(i=0;i<n;i++){
printf("Enter the free frame number:");
scanf("%d",&f[i]);
if(f[i]>tf){
```

```
printf("\n Invalid frame number\n");
i--;
}}printf("\n\t\t Page table");
printf("\n\t Page no \t Frame no");
for(i=0;i<pg;i++)
printf("\n\t %d\t\t%d",i,f[i]);
printf("\n Enter the logical address:");
scanf("%d",&off);
pg1=off/pg;
printf("\n The off set no:%d",off1);
pa=(f[pg1]*pg)+off1;
printf("\n The physical address:%d",pa);
}
```

## Output

```
 Enter the memory size:32
 Enter the process size:16
 Enter the page size:4
Enter the free frame number:1
Enter the free frame number:3
Enter the free frame number:4
Enter the free frame number:5
          Page table
       Page no                 Frame no
          0                    1
          1                    3
          2                    4
          3                    5
 Enter the logical address:6
  Page no:1
 The off set no:2
 The physical address:10
```

## Result:

The program for memory management using paging technique was implemented and hence verified.

## Viva Questions:

1. Explain paging technique.
2. Define pages, frames, offset in paging technique.
3. What is meant by logical and physical address?
4. What is thrashing?
5. What is meant by page hit, page fault?
6. What is the formula to calculate physical address?
7. What is Demand paging?
8. What is virtual memory?
9. What is Locality of Reference?
10. What is Fragmentation?

# Ex.No: 9. IMPLEMENTATION OF MEMORY MANAGEMENT SCHEME

## Aim

To write a program to implement memory management scheme.

## A. First fit Algorithm

## Algorithm

1. Start the process
2. Declare the size
3. Get the number of processes to be inserted
4. Allocate the first hole that is big enough searching
5. Start at the beginning of the set of holes
6. If not start at the hole that is sharing the pervious first fit search end
7. Compare the hole

8. if large enough then stop searching in the procedure
9. Display the values
10. Stop the process

## Program

```
#include<stdio.h>void main()
{
int i,j,temp,f[10],fp[10];
int no,p[15],part[15],pno,pr[15],prmem[15];
printf("\n*************");
printf("\n Implementation of first-fit algorithm");
printf("\n******************");
printf("\n Enter the number of partitions:");
scanf("%d",&no);
for(i=1;i<=no;i++)
{
p[i]=i;
printf("\n Enter the memory size for partition:%d:\t",i);
scanf("%d",&part[i]);
}
printf("\n Enter the number of process:");
scanf("%d",&pno);
for(i=1;i<=pno;i++)
{
pr[i]=i;
printf("\n Enter the size for process %d: \t",i);
scanf("%d",&prmem[i]);
}
printf("\n----------\n");
printf("process|\t Partition|\t Free_memory|\n");
printf("\n-------------\n");
j=1;
for(i=1;i<=no;i++)
{
```

```
f[i]=0;
fp[i]=0;
}
while(j<=pno)
{
for(i=1;i<=no;i++)
{
if((part[i]>=prmem[j])&&(f[i]==0))
{
part[i]=part[i]-prmem[j];
fp[j]=1;
f[i]=1;
printf("%d\t\t%d\t\t%d\n",pr[j],p[i],part[i]);
goto l1;
}
}
l1:
j++;
}
for(i=1;i<=no;i++)
{
if(f[i]==0)
{
printf ("%d\t\t %d \t\t \n",p[i],part[i]);
}
}
printf("\n The following process is not allocated:");
for(i=1;i<=pno;i++)
{
if(fp[i]==0)
{
printf("%d",pr[i]);
}
}
```

```
}
```

## Output

```
******************
 Implementation of first-fit algorithm
******************
 Enter the number of partitions:3
 Enter the memory size for partition:1: 60
 Enter the memory size for partition:2: 80
 Enter the memory size for partition:3: 100
 Enter the number of process:3
 Enter the size for process 1:  55
 Enter the size for process 2:  75
 Enter the size for process 3:  90
------------------------------------------------
process|        Partition|      Free_memory|
------------------------------------------------
1                  1                 5
2                  2                 5
3                  3                 10
 The following process is not allocated:0
```

## Result

The program for first fit was implemented and hence verified

## B.Best Fit Algorithm

## Algorithm

1. Start the process
2. Declare the size
3. Get the number of processes to be inserted
4. Allocate the best hole that is small enough searching
5. Start  at the best of the set of holes
6. If not start at the hole that is sharing the pervious best fit search end

7. Compare the hole
8. If small enough then stop searching in the procedure
9. Display the values
10. Stop the process

## Program

```
#include<stdio.h>
main()
{
int i,j,temp,f[10],fp[10];
int no,p[15],part[15],pno,pr[15],prmem[15];
printf("\n***********************");
printf("\n implementation of best-fit algorithm");
printf("\n**************************");
printf("\n Enter the number of partitions:");
scanf("%d",&no);
for(i=1;i<=no;i++)
{
p[i]=i;
printf("\n Enter the memory size for partition %d:\t",i);
scanf("%d",&part[i]);
}
for(i=1;i<=no;i++)
{
for(j=1;j<=i;j++)
{
if(part[j]>part[i])
{
temp=part[i];
part[i]=part[j];
part[j]=temp;
temp=p[i];
p[i]=p[j];
p[j]=temp;
}
}
}
printf("\n Enter the number of process:");
scanf("%d",&pno);
for(i=1;i<=pno;i++)
{
pr[i]=i;
printf("\n Enter the size for process %d:\t",i);
scanf("%d",&prmem[i]);
}
printf("\n--------------\n");
printf("PROCESS|\t PARTITION|\t FREE_MEMORY|\n");
printf("\n-----------\n");
j=1;
for(i=1;i<=no;i++)
{
f[i]=0;
fp[j]=0;
}
while(j<=pno)
{
for(i=1;i<=no;i++)
{
if((part[i]>=prmem[j])&&(f[i]==0))
{
part[i]=part[i]-prmem[j];
fp[j]=1;
f[i]=1;
printf("%d \t\t %d \t\t %d \n",pr[j],p[i],part[i]);
goto l1;
}
}
l1:
```

```
j++;
}
for(i=1;i<=no;i++)
{
if(f[i]==0)
{
printf("%d \t\t %d \t\t \n",p[i],part[i]);
}
}
printf("\n The following process is not allocated:");
for(i=1;i<=pno;i++)
{
if(fp[i]==0)
{
printf("%d",pr[i]);
}
}
}
```

## Output

```
***********************
 implementation of best-fit algorithm
**************************
 Enter the number of partitions:3
 Enter the memory size for partition 1: 2
 Enter the memory size for partition 2: 6
 Enter the memory size for partition 3: 9
 Enter the number of process:4
 Enter the size for process 1:  2
 Enter the size for process 2:  3
 Enter the size for process 3:  3
 Enter the size for process 4:  6
----------------------------------------------------------------------
PROCESS|        PARTITION|     FREE_MEMORY|
-----------------------------------------------------------------
1                    1                    0
2                    2                    3
3                    3                    6
 The following process is not allocated:4
```

## Result

The program for best fit was implemented and hence verified

## C.Worst Fit Algorithm

## Algorithm

1. Start the process
2. Declare the size
3. Get the number of processes to be inserted
4. Allocate the best hole that is small enough searching
5. Start at the best of the set of holes
6. If not start at the hole that is sharing the pervious best fit search end
7. Compare the hole
8. If small enough then stop searching in the procedure
9. Display the values
10. Stop the process

## Program

```
#include<stdio.h>
main()
{
int i,j,temp,f[10],fp[10];
int no,p[15],prmem[15],part[15],pr[15],pno;
printf("\n*******************\n");
printf("enter no of partitions:\n");
scanf("%d",&no);
for(i=1;i<=no;i++)
```

```
{
p[i]=i;
printf("enter the memory for partition %d\t",i);
scanf("%d",&part[i]);
}
for(i=1;i<=no;i++)
{
for(j=1;j<=i;j++)
{
if(part[j]<part[i])
{
temp=part[i];
part[i]=part[j];
part[j]=temp;
temp=p[i];
p[i]=p[j];
p[j]=temp;
}
}
}
printf("\n free memory");
for(i=1;i<=no;i++)
{
printf("\n partition %d:\t %d",p[i],part[i]);
}
printf("\n enter the number of process:");
scanf("%d",&pno);
for(i=1;i<=pno;i++)
{
pr[i]=i;
printf("\n enter the size of process %d:\t",i);
scanf("%d",&prmem[i]);
}
printf("\n-------------\n");
printf("process| \t partition \t free memory|\n");
printf("\n---------------\n");
j=1;
for(i=1;i<=no;i++)
{
f[i]=0;
fp[j]=0;
}
while(j<=pno)
{
for(i=1;i<=no;i++){
if((part[i]>=prmem[j])&&(f[i]==0))
{
part[i]=part[i]-prmem[j];
fp[j]=1;
f[i]=1;
printf("%d \t %d \t %d \n",pr[j],p[j],part[i]);
goto l1;
}
}
l1:
j++;
}for(i=1;i<=no;i++)
{
if(f[i]==0)
{
printf("\t %d \t %d \n",p[i],part[i]);
}
}
printf("\n the following process is not allocated:");
for(i=1;i<=pno;i++)
{
if(fp[i]==0)
{
```

```
printf("%d",pr[i]);
}
}
}
```

## Output

```
enter no of partitions:
3
enter the memory for partition 1       20
enter the memory for partition 2       30
enter the memory for partition 3       10
 free memory
 partition 2:    30
 partition 1:    20
 partition 3:    10
 enter the number of process:3
 enter the size of process 1:   12
 enter the size of process 2:   22
 enter the size of process 3:   7
-----------------------------------------------
process|        partition       free memory|


-----------------------------------------------
1                   2                  18
3                   3                  13
                    3                  10

 the following process is not allocated:2
```

## Result

The program for worst fit was implemented and hence verified.

## Viva Questions:

1. What do you mean by First Fit?
2. What do you mean by Best Fit?

3. What do you mean by Worst Fit?
4. How is memory protected in a paged environment?
5. What is External Fragmentation?
6. What do you mean by Compaction?
7. Define Secondary Memory
8. What is called memory mapping?
9. Define Effective Access Time.
10. What is the use of Valid-Invalid Bits in Paging?

**Ex No: 10** **PAGE REPLACEMENT ALGORITHMS**

**Ex. No 10 ,A,** **IMPLEMENTATION OF FIFO ALGORITHM**

## Aim:

To implement First in First Out page replacement technique.

## Algorithm:

**Step 1:** Start the process
**Step 2:** Declare the size with respect to page length
**Step 3:** Check the need of replacement from the page to memory
**Step 4:** Check the need of replacement from old page to new page in memory
**Step 5:** Forma queue to hold all pages
**Step 6:** Insert the page require memory into the queue
**Step 7:** Check for bad replacement and page fault
**Step 8:** Get the number of processes to be inserted
**Step 9:** Display the values
**Step 10:** Stop the process

## Program:

```
#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:  20
ENTER THE PAGE NUMBER :       7 0 1 2 0 3 0 4 2 3 0 3 2 1 2 0 1 7 0 1
ENTER THE NUMBER OF FRAMES :3
```

```
    ref string      page frames
7           7     -1    -1
0           7     0     -1
1           7     0     1
2           2     0     1
0
3           2     3     1
0           2     3     0
4           4     3     0
2           4     2     0
3           4     2     3
0           0     2     3
3
2
1           0     1     3
2           0     1     2
0
1
7           7     1     2
0           7     0     2
1           7     0     1
Page Fault Is 15
```

## Result:

The program for First in First Out page replacement technique was implemented and hence verified.

## Ex No: 10B IMPLEMENTATION OF LRU ALGORITHM

## Aim:

To implement Least Recently Used page replacement technique.

## Algorithm:

**Step 1:** Start the process

**Step 2:** Declare the size

**Step 3:** Get the number of pages to be inserted

**Step 4:** Get the value

**Step 5:** Declare counter and stack

**Step 6:** Select the least recently used page by counter value

**Step 7:** Stack them according the selection.

**Step 8:** Display the values

**Step 9:** Stop the process

## Program:

```
#include<stdio.h>
main()
{
        int q[20],p[50],c=0,c1,d,f,i,j,k=0,n,r,t,b[20],c2[20];
        printf("Enter no of pages:");
        scanf("%d",&n);
        printf("Enter the reference string:");
        for(i=0;i<n;i++)
        scanf("%d",&p[i]);
        printf("Enter no of frames:");
        scanf("%d",&f);
        q[k]=p[k];
        printf("\n\t%d\n",q[k]);
        c++;
        k++;
        for(i=1;i<n;i++)
{
c1=0;
```

```
for(j=0;j<f;j++)
{
if(p[i]!=q[j])
c1++;
}
if(c1==f)
{
c++;
if(k<f)
{
q[k]=p[i];
k++;
for(j=0;j<k;j++)
printf("\t%d",q[j]);
printf("\n");
}
else
{
for(r=0;r<f;r++)
{
c2[r]=0;
for(j=i-1;j<n;j--)
{
if(q[r]!=p[j])
c2[r]++;
else
break;
}
}
for(r=0;r<f;r++)
b[r]=c2[r];
for(r=0;r<f;r++)
{
for(j=r;j<f;j++)
{
if(b[r]<b[j])
{
t=b[r];
b[r]=b[j];
b[j]=t;
}
}
}
for(r=0;r<f;r++)
{
if(c2[r]==b[0])
q[r]=p[i];
printf("\t%d",q[r]);
}
printf("\n");
}
}
}
printf("\nThe no of page faults is %d",c);
}
```

## Output:

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

## Result:

The program for Least Recently Used page replacement technique was implemented and hence verified .

## Ex No: 10C IMPLEMENTATION OF LFU ALGORITHM

## Aim:

To implement Least Frequently Used page replacement technique.

## Algorithm:

**Step 1:** Start the process

**Step 2:** Declare the size

**Step 3:** Get the number of pages to be inserted

**Step 4:** Get the value

**Step 5:** Declare counter and stack

**Step 6:** Select the least frequently used page by counter value

**Step 7:** Stack them according the selection.

**Step 8:** Display the values

**Step 9:** Stop the process

## Program:

```
#include<stdio.h>
int main()
{
  int f,p;
  int pages[50],frame[10],hit=0,count[50],time[50];
  int i,j,page,flag,least,minTime,temp;
  printf("Enter no of frames : ");
  scanf("%d",&f);
  printf("Enter no of pages : ");
  scanf("%d",&p);

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

```
  frame[i]=-1;
}
for(i=0;i<50;i++)
{
  count[i]=0;
}
printf("Enter page no : \n");
for(i=0;i<p;i++)
{
  scanf("%d",&pages[i]);
}
printf("\n");
for(i=0;i<p;i++)
{
  count[pages[i]]++;
  time[pages[i]]=i;
  flag=1;
  least=frame[0];
  for(j=0;j<f;j++)
  {
    if(frame[j]==-1 || frame[j]==pages[i])
    {
      if(frame[j]!=-1)
      {
          hit++;
      }
      flag=0;
      frame[j]=pages[i];
      break;
    }
    if(count[least]>count[frame[j]])
    {
      least=frame[j];
    }
    }
    if(flag)
    {
      minTime=50;
      for(j=0;j<f;j++)
      {
        if(count[frame[j]]==count[least] && time[frame[j]]<minTime)
        {
          temp=j;
          minTime=time[frame[j]];
        }
      }
      count[frame[temp]]=0;
      frame[temp]=pages[i];
    }
    for(j=0;j<f;j++)
    {
      printf("%d ",frame[j]);
    }
    printf("\n");
  }
  printf("Page hit = %d",hit);
  return 0;
}
```

## Output

```
Enter no of frames: 3
Enter no of pages:10
Enter page no:
2
3
4
2
1
3
7
5
4
```

```
3

2        -1       -1
2        3        -1
2        3        4
2        3        4
2        1        4
2        1        3
2        7        3
2        7        5
2        4        5
2        4        3
Page hit=1
```

## Result:

The program for Least Frequently Used page replacement technique was implemented and hence verified

## EXP:NO:10 D) OPTIMAL PAGE REPLACEMENT ALGORITHM

### AIM:

TO write the c program to implement the optimal page replacement algorithm.

### ALGORITHM:

**Step 1:** Declare the size

**Step 2:** Get the number of pages to be inserted

**Step 3:** Get the value

**Step 4:** Declare counter and stack

**Step 5:** Select the later used page by counter value

**Step 6:** Stack them according the selection.

**Step 7:** Display the values

**Step 8:** Stop the process

### PROGRAM:

```
#include<stdio.h>

#include<conio.h>

main()

{

int fr[5],i,j,k,t[5],p=1,flag=0,page[25],psz,nf,t1,u[5];

clrscr();

printf("enter the number of frames:");

scanf("%d",&nf);

printf("\n enter the page size");

scanf("%d",&psz);

printf("\nenter the page sequence:");

for(i=1; i<=psz; i++)

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

for(i=1; i<=nf; i++)

fr[i]=-1;

for(i=1; i<=psz; i++)

{

if(full(fr,nf)==1)

break;

else

{
```

```
flag=0;

for(j=1; j<=nf; j++)

{

if(page[i]==fr[j])

{

flag=1;

printf("\t%d:\t",page[i]);

break;

}

}

if(flag==0)

{

fr[p]=page[i];

printf("\t%d:\t",page[i]);

p++;

}

for(j=1; j<=nf; j++)

printf(" %d  ",fr[j]);

printf("\n");

}

}
```

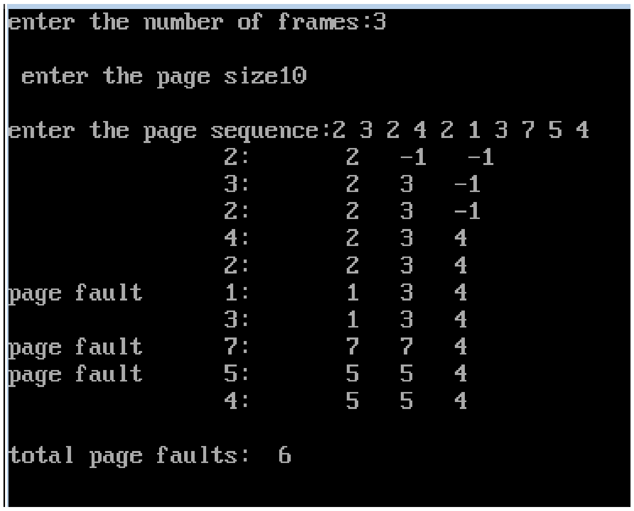
```
p=0;

for(; i<=psz; i++)

{

flag=0;

for(j=1; j<=nf; j++)

{

if(page[i]==fr[j])

{

flag=1;

break;

}

}

if(flag==0)

{

p++;

for(j=1; j<=nf; j++)

{

for(k=i+1; k<=psz; k++)

{

if(fr[j]==page[k])

{
```

```
u[j]=k;

break;

}

else

u[j]=21;

}

}

for(j=1; j<=nf; j++)

t[j]=u[j];

for(j=1; j<=nf; j++)

{

for(k=j+1; k<=nf; k++)

{

if(t[j]<t[k])

{

t1=t[j];

t[j]=t[k];

t[k]=t1;

}

}

for(j=1; j<=nf; j++)
```

```
{

if(t[1]==u[j])

{

fr[j]=page[i];

u[j]=i;

}

}

printf("page fault\t");

}

else

printf("\t");

printf("%d:\t",page[i]);

for(j=1; j<=nf; j++)

printf(" %d  ",fr[j]);

printf("\n");

}

printf("\ntotal page faults:  %d",p+3);

getch();

}

int full(int a[],int n)

{
```

```
int k;

for(k=1; k<=n; k++)

{

if(a[k]==-1)

return 0;

}

return 1;

}
```

**OUTPUT:**



```
enter the number of frames:3

 enter the page size10

enter the page sequence:2 3 2 4 2 1 3 7 5 4
                2:       2   -1   -1
                3:       2   3   -1
                2:       2   3   -1
                4:       2   3   4
                2:       2   3   4
page fault      1:       1   3   4
                3:       1   3   4
page fault      7:       7   7   4
page fault      5:       5   5   4
                4:       5   5   4

total page faults:  6
```

## Viva Questions:

1. What is page and frame in OS?
2. Explain FIFO technique?
3. What is meant by Belady's Anamoly
4. What are the other page replacement techniques?
5. Explain LRU technique?
6. Advantages of LRU over FIFO

7. Disadvantages of LRU
8. Explain LFU technique?
9. Advantages of LFU over FIFO,LRU.
10. Which is the best page replacement technique?

## Ex No: 11A

## IMPLEMENTATION OF SINGLE LEVEL DIRECTORY

### Aim:

To write a program to implement Single Level Directory structure.

### Algorithm:

**Step 1:** Read the number of directories to be created.
**Step 2:** Input the number of files for each directory.
**Step 3:** Give the file names for the files.
**Step 4:** Display the single level directory containing files in each.

### Program:

```
#include<stdio.h>
main()
{
intmaster,s[20];
char f[20][20][20];
char d[20][20];
inti,j;
printf("enter number of directorios:");
scanf("%d",&master);
printf("enter names of directories:");
for(i=0;i<master;i++)
scanf("%s",d[i]);
printf("enter size of directories:");
for(i=0;i<master;i++)
scanf("%d",&s[i]);
printf("enter the file names :");
for(i=0;i<master;i++)
for(j=0;j<s[i];j++)
scanf("%s",f[i][j]);
printf("\n");
printf(" directory\tsize\tfilenames\n");
printf("*****************************************************\n");
for(i=0;i<master;i++)
{
printf("%s\t\t%2d\t",d[i],s[i]);
for(j=0;j<s[i];j++)
printf("%s\n\t\t\t",f[i][j]);
printf("\n");
}
printf("\t\n");
}
```

## Output:

```
enter number of directorios:2
enter names of directories:dir1 dir2
enter size of directories:2 1
enter the file names :
f1
f2
f3

directory      size    filenames
*************************************************
dir1            2      f1
f2

dir2            1     f3
```

## Result

Thus the single level directory has been implemented in C.

**Ex No: 11B**

# IMPLEMENTATION OF TWO LEVEL DIRECTORY

## Aim:

To write a program to implement two level directory structure.

## Algorithm:

**Step 1:** Read the number of directories to be created.  
**Step 2:** Input the number of subdirectories and names of the subdirectories for each directory.  
**Step 3:** Give the file names for the files under the subdirectories.  
**Step 4:** Display the two level structure for each directory created.

## Program:

```
#include<stdio.h>
#include<conio.h>
structst
{
chardname[10];
charsdname[10][10];
charfname[10][10][10];
intds,sds[10];
}dir[10];
void main()
{
inti,j,k,n;
clrscr();
printf("enter number of directories:");
scanf("%d",&n);
for(i=0;i<n;i++)
{
printf("enter directory %d names:",i+1);
scanf("%s",&dir[i].dname);
printf("enter size of directories:");
scanf("%d",&dir[i].ds);
for(j=0;j<dir[i].ds;j++)
{
printf("enter subdirectory name and size:");
scanf("%s",&dir[i].sdname[j]);
scanf("%d",&dir[i].sds[j]);
for(k=0;k<dir[i].sds[j];k++)
{
printf("enter file name:");
scanf("%s",&dir[i].fname[j][k]);
}
}
}
printf("\ndirname\t\tsize\tsubdirname\tsize\tfiles");
printf("\n*******************************************************\n");
for(i=0;i<n;i++)
{
printf("%s\t\t%d",dir[i].dname,dir[i].ds);
for(j=0;j<dir[i].ds;j++)
{
printf("\t%s\t\t%d\t",dir[i].sdname[j],dir[i].sds[j]);
for(k=0;k<dir[i].sds[j];k++)
printf("%s\t",dir[i].fname[j][k]);
printf("\n\t\t");
}
printf("\n");
}
getch();
}
```

## Output:

```
Enter the number of directories: 1
Enter directory1 name: Dir1
Enter size of directories: 2
Enter subdirectory name and size: Sub1  1
Enter file name: File1
Enter subdirectory name and size: Sub2  1
Enter file name: File2
dirname         size    subdirname      size    files
*******************************************
Dir1            2       Sub1            1       File1
                        Sub2            1       File2
```

## Result:

Thus the two level directory has been implemented in C.

**Ex No: 11C**

# IMPLEMENTATION OF HIERARCHY LEVEL DIRECTORY

## Aim:

To write a program to implement Hierarchy level directory.

## Algorithm:

**Step 1:** Read the Directory for which the hierarchy structure to be displayed.

**Step 2:** Write commands to access through the subdirectories and files in the given directory.

**Step 3:** If subdirectories found print them as next level of the directory

**Step 4:** If file found print them as next sub level of the sub directory

## Program:

```
#define  _XOPEN_SOURCE 500
#include<ftw.h>
#include<stdio.h>
#include<stdlib.h>
#include<string.h>
#include<stdint.h>
#include<limits.h>
#define TRUE 1
#define FALSE 0
```

```
#define MAXDEPTH 20
staticintdisplay_info(const char *fpath, conststruct stat *sb, inttflag, struct FTW *ftwbuf)
{
char blanks[PATH_MAX];
const char *filename=fpath+ftwbuf->base;
int width = 4*ftwbuf->level;
memset(blanks ,' ', width);
blanks[width] = '\0';
printf("%s%s",blanks,filename);
if(tflag==FTW_DNR)
printf("(unreadabledirectory)");
else if(tflag==FTW_SL)
printf("(symboliclink)");
else if(tflag==FTW_SLN)
printf("(brokensymboliclink)");
else if(tflag==FTW_NS)
printf("statfailed");
printf("\n");
return 0;
}
int main(intargc,char *argv[])
{
int flags=0;
int status;
intch;
char options[]=":cdpm";
opterr=0;
while(TRUE)
{
ch=getopt(argc,argv,options);
///*itreturns−1whenitfindsnomoreoptions */
if(-1 == ch)
break;
switch(ch)
{
case 'c':
flags|=FTW_CHDIR;
break;
case 'd':
flags|=FTW_DEPTH;
break;
case 'p':
flags|=FTW_PHYS;
break;
case 'm':
flags|=FTW_MOUNT;
break;
default:
fprintf(stderr,"Badoptionfound.\n");
return 1;
}
}
if(optind<argc)
{
while(optind<argc)
{
status=nftw(argv[optind],display_info,MAXDEPTH,flags);
if(-1 == status)
{
perror("nftw");
exit(EXIT_FAILURE);
}
else
optind++;
} }
else
{
status=nftw(".",display_info,MAXDEPTH,flags);
if(-1==status)
{
perror("nftw");
exit(EXIT_FAILURE);
} }
exit(EXIT_SUCCESS);
}
```

## Output:

```
enter name of dir/file(under root):Root
enter 1 for dir/ 2 for file:1
no of sub directories /files (for Root):2
enter name of dir/file(under Root):Java
enter 1 for dir/ 2 for file:1
no of sub directories /files (for Java):1
enter name of dir/file(under Java):JP
enter 1 for dir/ 2 for file:2
enter name of dir/file(under Root):HTML
enter 1 for dir/ 2 for file:1
no of sub directories /files (for HTML):1
enter name of dir/file(under HTML):DHTML
enter 1 for dir/ 2 for file:1
no of sub directories /files (for DHTML):1
enter name of dir/file(under DHTML):XML
enter 1 for dir/ 2 for file:1
no of sub directories /files (for XML):1
enter name of dir/file(under XML):ADo
enter 1 for dir/ 2 for file:1
no of sub directories /files (for ADo):AD
enter name of dir/file(under ADo):AD
enter 1 for dir/ 2 for file:2
```

## Result:

Thus the hierarchy level directory has been implemented in C.

## Viva Questions:

1. Explain Single Level Directory (SLD)?
2. What are the various File directory structures?
3. Advantages and Disadvantages of SLD
4. Give a real time example of SLD
5. Explain Two Level Directory (TLD)?
6. Advantages of TLD over SLD
7. Explain Hierarchical Level Directory (HLD)?
8. What is Directed acyclic graph?
9. What are the other file organization methods?
10. Draw a sample DAG?

**Ex No: 12A**

# IMPLEMENTATION OF SEQUENTIAL FILE ALLOCATION

## Aim:

To write a program to implement sequential file allocation.

## Algorithm:

**Step 1:** Create a disk space using array.
**Step 2:** Give the file length and starting block number.
**Step 3:** Allocate each block of the file sequentially in disk.
**Step 4:** The disk space is checked to ensure the block is allocated or not.

## Program

```
#include<stdio.h>
#include<conio.h>
main()
{
int f[50],i,st,j,len,c,k;
clrscr();
for(i=0;i<50;i++)
f[i]=0;
printf("\n Enter the starting block & length of file");
scanf("%d%d",&st,&len);
for(j=st;j<(st+len);j++)
if(f[j]==0)
{
f[j]=1;
printf("\n%d->%d",j,f[j]);
}
else
{
printf("Block already allocated");
break;
}
if(j==(st+len))
printf("\n the file is allocated to disk");
printf("\n if u want to enter more files?(y-1/n-0)");
scanf("%d",&c);
if(c==1)
goto X;
return 0;}
```

## Output

```
 Enter the starting block & length of file4 10

4->1

5->1

6->1

7->1

8->1

9->1

10->1

11->1

12->1

13->1

the file is allocated to disk

if u want to enter more files?(y-1/n-0)
```

**RESULT**

Thus sequential file allocation has been implemented in C.

**Ex No: 12B**

# IMPLEMENTATION OF INDEXED FILE ALLOCATION

## Aim:

To write a C program to implement indexed file allocation.

## Algorithm:

**Step 1:** Enter the number of files along with their file names.
**Step 2:** Give the file size and block size for each file.
**Step 3:** Enter the block numbers for each block in file.
**Step 4:** Display the indexed file allocation of each file.

## Program

```
#include<stdio.h>
#include<stdlib.h>
#include<conio.h>
int main()
{
int a[100],ind,i,k,j,index[100],n,c,count=0,block;
charfname[50];
clrscr();
for(i=0;i<100;i++)
a[i]=0;
X:
printf("\nenter the parent file name\n");
scanf("%s",fname);
printf("enter the index block\n");
scanf("%d",&ind);
if(a[ind]!=1)
{
a[ind]=1;
printf("\nenter no of files on index\n");
scanf("%d",&n);
printf("\n\t----------------------------------------------------\n");
printf("\tfile name\tindex block\n");
printf("\t%s\t%d",fname,ind);
printf("\n\t------------------------------------------------------\n");
printf("\nenter the files....");
}
y:
for(i=0;i<n;i++)
{
scanf("%d",&index[i]);
}
for(i=0;i<n;i++)
{
if(a[index[i]]==0)
count++;
}
if(count==n)
{
for(j=0;j<n;j++)
if(ind<index[j]||ind>index[j])
a[index[j]]=1;
printf("\nfile is allocated");
printf("\nfile is indexed");
for(k=0;k<n;k++)
printf("\n%d---->%d:%d",ind,index[k],a[index[k]]);
}
else
{
exit(0);
}}
```

## Output:

```
enter the parent file name    srinivasan
enter the index block  14
enter no of files on index  5
        ---------------------------------------------------
file name       index block
srinivasan      14
        -----------------------------------------------------
enter the files....2 3 4 5 20
file is allocated
file is indexed
14->2:1
14->3:1
14->4:1
14->5:1
14->20:1
```

## Result

Thus indexed file allocation has been implemented in C.

**Ex No: 12C**

## IMPLEMENTATION OF LINKED FILE ALLOCATION

## Aim:

To write a C program to implement linked file allocation.

## Algorithm:

**Step 1:** Enter the number of files along with their file names.
**Step 2:** Give the file size and block size for each file.
**Step 3:** Enter the block numbers for each block in file.
**Step 4:** Display the linked file allocation of each file using their block delimiters.

## Program:

```
#include<stdio.h>
struct file
{
charfname[50];
intstart,size,block[10];
}f[50];
main()
{
inti,j,n;
printf("Enter no. of files:");
scanf("%d",&n);
for(i=0;i<n;i++)
{
printf("Enter file name:");
scanf("%s",&f[i].fname);
printf("Enter starting block:");
scanf("%d",&f[i].start);
f[i].block[0]=f[i].start;
printf("Enter no.of blocks:");
scanf("%d",&f[i].size);
printf("Enter block numbers:");
for(j=1;j<=f[i].size;j++)
{
scanf("%d",&f[i].block[j]);
}
}
printf("\n---------------------------------------------------------");
printf("\n|File\t|\tstart\t|\tsize\t|\tblock\n");
printf("\n----------------------------------------------------------\n");

for(i=0;i<n;i++)
{
printf("%s\t\t%d\t\t%d\t",f[i].fname,f[i].start,f[i].size);
printf("%d",f[i].start);
for(j=0;j<=f[i].size-1;j++)
printf("--->%d",f[i].block[j+1]);
printf("\n");
printf("\n-------------------------------------------------------------\n");
}
}
```

## Output:

```
Enter no. of files:2
Enter file name:srinivasan
Enter starting block:3
Enter no.of blocks:3
Enter block numbers:1  2  4
Enter file name:seenu
Enter starting block:6
Enter no.of blocks:3
Enter block numbers:10  20  12
-------------------------------------------------------
|File   |      start   |      size    |      block
--------------------------------------------------------
srinivasan     3         3              3--->1--->2--->4
-----------------------------------------------------------
seenu          6         3              6--->10--->20--->12
-----------------------------------------------------------
```

## Result

Thus linked file allocation has been implemented in C.

## Viva Questions

1. What is a file? What are the different file types?
2. What are the file access methods?
3. Explain Sequential File allocation?
4. Give some real time examples of sequential file allocation?
5. What is the need for efficient file allocation strategies?
6. Explain Indexed File allocation?
7. Advantages of indexed file allocation.
8. Explain Linked File allocation?
9. Advantages of linked file allocation?
10. What is directory?

# Ex. no. 13. IMPLEMENTATION OF VARIOUS DISK SCHEDULING ALGORITHMS

## **Ex.No.13.a.** FCFS (First-Come, First-Served)

```
#include <stdio.h>
void FCFS(int requests[], int n, int head) {
    int total_seek = 0;
    printf("Seek Sequence: %d", head);
    for (int i = 0; i < n; i++) {
        total_seek += abs(requests[i] - head);
        head = requests[i];
        printf(" -> %d", head);
    }
    printf("\nTotal Seek Time: %d\n", total_seek);
}
int main() {
    int requests[] = {98, 183, 37, 122, 14, 124, 65, 67};
    int n = sizeof(requests) / sizeof(requests[0]);
    int head = 53;
    FCFS(requests, n, head);
    return 0;
}
```

## Ex.No 13. B. SSTF (Shortest Seek Time First)

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

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

void SSTF(int requests[], int n, int head) {
    int total_seek = 0;
    bool visited[n];
    for (int i = 0; i < n; i++) visited[i] = false;

    printf("Seek Sequence: %d", head);
    for (int i = 0; i < n; i++) {
        int min_distance = __INT_MAX__;
        int index = -1;
        for (int j = 0; j < n; j++) {
            if (!visited[j] && abs(requests[j] - head) < min_distance) {
                min_distance = abs(requests[j] - head);
                index = j;
            }
        }
        visited[index] = true;
        total_seek += min_distance;
        head = requests[index];
        printf(" -> %d", head);
    }
    printf("\nTotal Seek Time: %d\n", total_seek);
}
```

```
int main() {
    int requests[] = {98, 183, 37, 122, 14, 124, 65, 67};
    int n = sizeof(requests) / sizeof(requests[0]);
    int head = 53;
    SSTF(requests, n, head);
    return 0;
}
```

## Ex. No 13 . SCAN Algorithm

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

void SCAN(int requests[], int n, int head, int disk_size, int direction) {
    int total_seek = 0;
    int size = n + 2;
    int seek_sequence[size];
    int index = 0;

    requests[n] = 0;
    requests[n + 1] = disk_size - 1;
    n += 2;

    for (int i = 0; i < n - 1; i++) {
        for (int j = 0; j < n - i - 1; j++) {
            if (requests[j] > requests[j + 1]) {
                int temp = requests[j];
                requests[j] = requests[j + 1];
                requests[j + 1] = temp;
            }
        }
    }

    int pos;
    for (int i = 0; i < n; i++) {
        if (head < requests[i]) {
            pos = i;
            break;
        }
    }

    if (direction == 1) {
        for (int i = pos; i < n; i++) {
            seek_sequence[index++] = requests[i];
        }
        for (int i = pos - 1; i >= 0; i--) {
            seek_sequence[index++] = requests[i];
        }
    } else {
        for (int i = pos - 1; i >= 0; i--) {
            seek_sequence[index++] = requests[i];
        }
        for (int i = pos; i < n; i++) {
            seek_sequence[index++] = requests[i];
        }
    }

    printf("Seek Sequence: %d", head);
    for (int i = 0; i < size; i++) {
        total_seek += abs(seek_sequence[i] - head);
        head = seek_sequence[i];
        printf(" -> %d", head);
    }
    printf("\nTotal Seek Time: %d\n", total_seek);
}
int main() {
    int requests[] = {98, 183, 37, 122, 14, 124, 65, 67};
    int n = sizeof(requests) / sizeof(requests[0]);
    int head = 53;
    SSTF(requests, n, head);
    return 0;
}
```