SYLLABUS

Course Outcomes:

1. Demonstrate the fundamental UNIX commands & system calls
2. Apply the scheduling algorithms for the given problem
3. Apply the process synchronization concept using shared memory, semaphores for the given situation.
4. Experiment an algorithm to detect and avoid dead lock
5. Apply the various methods used for memory management and page replacement algorithm.

1) a) Study of Unix/Linux general purpose utility command list: man, who, cat, cd, cp, ps, ls, mv, rm, mkdir, rmdir, echo, more, date, time, kill, history, chmod, chown,finger, pwd, cal, logout, shutdown.

b) Study of vi editor.

c) Study of Bash shell, Bourne shell and C shell in Unix/Linux operating system.

d) Study of Unix/Linux files system (tree structure).

e) Study of .bashrc, /etc/bashrc and Environment variables.

2) Write a C program that makes a copy of a file using standard I/O, and system calls.

3) Write a C program to emulate the UNIX ls –l command.

4) Write a C program that illustrates how to execute two commands concurrently withacommand pipe. (Ex: - ls –l | sort)

5) Simulate the following CPU scheduling algorithms:

(a) Round Robin (b) SJF (c) FCFS (d) Priority

6) Multiprogramming-Memory management-Implementation of fork (), wait (), exec() and exit (), System calls.

7) Simulate the following:

a) Multiprogramming with a fixed number of tasks (MFT)

b) Multiprogramming with a variable number of tasks (MVT)

8) Simulate Bankers Algorithm for Dead Lock Avoidance.

9) Simulate Bankers Algorithm for Dead Lock Prevention.

10) Simulate the following page replacement algorithms:

a) FIFO b) LRU c) LFU

11) Simulate the following File allocation strategies:

(a) Sequenced (b) Indexed (c) Linked

12) Write a C program that illustrates two processes communicating using sharedmemory.

13) Write a C program to simulate producer and consumer problem usingsemaphores.

14) Write C program to create a thread using pthreads library and let it run itsfunction.

15) Write a C program to illustrate concurrent execution of threads using pthreads library.

1. a) Study of Unix/Linux general purpose utility command list: man, who, cat, cd, cp, ps, ls, mv, rm, mkdir, rmdir, echo, more, date, time, kill, history, chmod, chown, finger, pwd, cal, logout, shutdown.

1.man - view manual pages for UNIX commands

Syntax: man [-s section] item

```
$ man cat
```

2.who - displays the list of users logged presently

Syntax: who [option]… [file][arg1]

```
$ who
```

3.cat - concatenate files and show contents to the standard output

Syntax: cat [option]…[file]

```
$ cat > file1
hello
```

4. cd - change directory

Syntax: cd [option] directory

```
$ cd dir1
```

5.cp - copy files

Syntax: cp [option] source destination

```
$ cp file1 file2
```

6.ps - Reports process status

Syntax: Ps [options]

```
$ ps
```

7. ls - List files & directories

Syntax: ls [option] [file]

```
$ ls
```

8.mv - Rename or move files & directories to another location

Syntax: mv [option] source destination

```
$ mv file1 file2
```

9.rm - removes files & directories

Syntax: rm [option]…[file]

```
$ rm file1
```

10.mkdir - makes new directory

Syntax: mkdir [option] directory

$ mkdir dir1

11.rmdir - removes directory

Syntax: rmdir [option] directory

$ rmdir dir1

12.echo - displays a line of text to the standard output

Syntax: $ echo "Hello, World!"

$ echo $x

13.more - basic pagination when viewing text files or parsing UNIX commands output

Syntax: more [-options] [-num] [+/pattern] [+linenum] [file_name]

$ more +/reset sample.txt

$ more +30 sample.txt

14. date - Show current date & time

Syntax: date [+format]

$ date +%d/%m/%y

15. time - shows current time

$ time

16. kill - terminates a specified process

Syntax: Kill PID

$ kill 4901

17.history - displays history commands in the current session

Syntax: history [options]

$ history

18. chmod - change file / directory access permissions

Symbolic mode

Syntax: chmod [ugoa][[+-=][mode]] file

i. The first optional parameter indicates who – this can be (u)ser, (g)roup, (o)thers or (a)ll
ii. The second optional parameter indicates opcode – this can be for adding (+), removing (-) or assigning (=) a permission.

iii. The third optional parameter indicates the mode – this can be (r)ead, (w)rite, or e(x)ecute.

```
$ chmod o-w file1
```

Numeric mode

Syntax: chmod [mode] file

i. The mode is a combination of three digits – the first digit indicates the permission for the user, the second digit for the group, and the third digit for others.
ii. Each digit is computed by adding the associated permissions. Read permission is '4', write permission is '2' and execute permission is '1'.

```
$ chmod 777 file1
```

19. chown - change file / directory ownership

Syntax: chown [owner] [file]

```
$ chown user2 file1
```

20. finger - displays user info if login is known

Syntax: finger username

```
$ finger user2
```

21. pwd - confirm current directory

Syntax: pwd [option]

```
$ pwd
```

22. cal - displays calendar

Syntax: cal [[month] year]

```
$ cal 6 2019
```

23. logout - logs off UNIX

Syntax: Logout [options]

```
$ logout
```

24. shutdown - brings the system down in a secure way

Syntax: shutdown [options]

```
$ shutdown
```

1) b) Study of vi editor.

- Visual editor for editing programs.
  - The vi editor is the most popular and classic text editor in the Linux family.
  - This editor enables you to edit lines in context with other lines in the file.
- Below, are some reasons which make it a widely used editor?
  - It is available in almost all Linux Distributions
  - It works the same across different platforms and Distributions
  - It requires very few resources.
  - It is more user-friendly than other editors such as the ed or the ex.
- We can use the vi editor to edit an existing file or to create a new file from scratch.
- We can also use this editor to just read a text file.
- An improved version of the vi editor which is called the VIM has also been made available now. Here, VIM stands for Vi IMproved.

Starting the vi Editor

- To launch the vi Editor -Open the Terminal (CLI) and type

vi <filename_NEW> or <filename_EXISTING>

& if you specify an existing file, then the editor would open it for you to edit. Else, you can create a new file.

The following table lists out the basic commands to use the vi editor –

S. No	Command	Description
1	vi filename	Creates a new file if it already does not exist, otherwise opens an existing file.
2	vi –R filename	Opens an existing file in the read-only mode.

Operation Modes

- To work on vi editor, we need to understand its operation modes.
  - Command mode − This mode enables you to perform administrative tasks such as saving the files, executing the commands, moving the cursor, cutting (yanking) and pasting the lines or words, as well as finding and replacing. In this mode, whatever you type is interpreted as a command.
  - Insert mode − This mode enables you to insert text into the file. Everything that's typed in this mode is interpreted as input and placed in the file.
- vi always starts in the command mode. To enter text, you must be in the insert mode for which simply type i. To come out of the insert mode, press the Esc key, which will take you back to the command mode.

vi Editing commands

Note: You should be in the "command mode" to execute these commands.

- vi editor is case-sensitive so make sure to type the commands in the right letter-case, otherwise you will end up making undesirable changes to the file.

S. No	Command	Description
1	i	Insert at cursor (goes into insert mode)
2	a	Write after cursor (goes into insert mode)
3	A	Write at the end of line (goes into insert mode)
4	ESC	Terminate insert mode
5	u	Undo last change
6	U	Undo all changes to the entire line
7	o	Open a new line (goes into insert mode)
8	dd	Delete line
9	3dd	Delete 3 lines.
10	D	Delete contents of line after the cursor
11	C	Delete contents of a line after the cursor and insert new text. Press ESC key to end insertion.
12	dw	Delete word
13	4dw	Delete 4 words
14	cw	Change word
15	x	Delete character at the cursor
16	r	Replace character
17	R	Overwrite characters from cursor onward
18	s	Substitute one character under cursor continue to insert
19	S	Substitute entire line and begin to insert at the beginning of the line
20	~	Change case of individual character

Moving within a file

Note: You need to be in the "command mode" to move within a file.

- The default keys for navigation are mentioned below else; you can also use the arrow keys on the keyboard.

S. No	Command	Description
1	k	Move cursor up
2	j	Move cursor down
3	h	Move cursor left
4	l	Move cursor right

Saving and Closing the file

Note: You should be in the "command mode" to exit the editor and save changes to the file.

S. No	Command	Description
1	Shift+zz	Save the file and quit
2	:w	Save the file but keep it open
3	:q	Quit without saving
4	:wq	Save the file and quit

1) c) Study of Bash shell, Bourne shell and C shell in Unix/Linux operating system.

Shell Programming

- A shell is a program that provides an interface between a user and an operating system (OS) kernel.
- An OS starts a shell for each user when the user logs in or opens a terminal or console window.
- A kernel is a program that:
- Controls all computer operations.
- Coordinates all executing utilities
- Ensures that executing utilities do not interfere with each other or consume all system resources.
- Schedules and manages all system processes.
- By interfacing with a kernel, a shell provides a way for a user to execute utilities and programs.

Types of Shell

Bourne Shell (sh)

- The Bourne shell is one of the original shells, developed for UNIX computers by Stephen Bourne at AT&T Bell Labs in 1977.
- It offers features such as input and output redirection, shell scripting with string and integer variables, and condition testing and looping.
- Command full-path name is /bin/sh and /sbin/sh.
- Default prompt for a non-root user is $.
- Default prompt for a root user is #.

C Shell (csh)

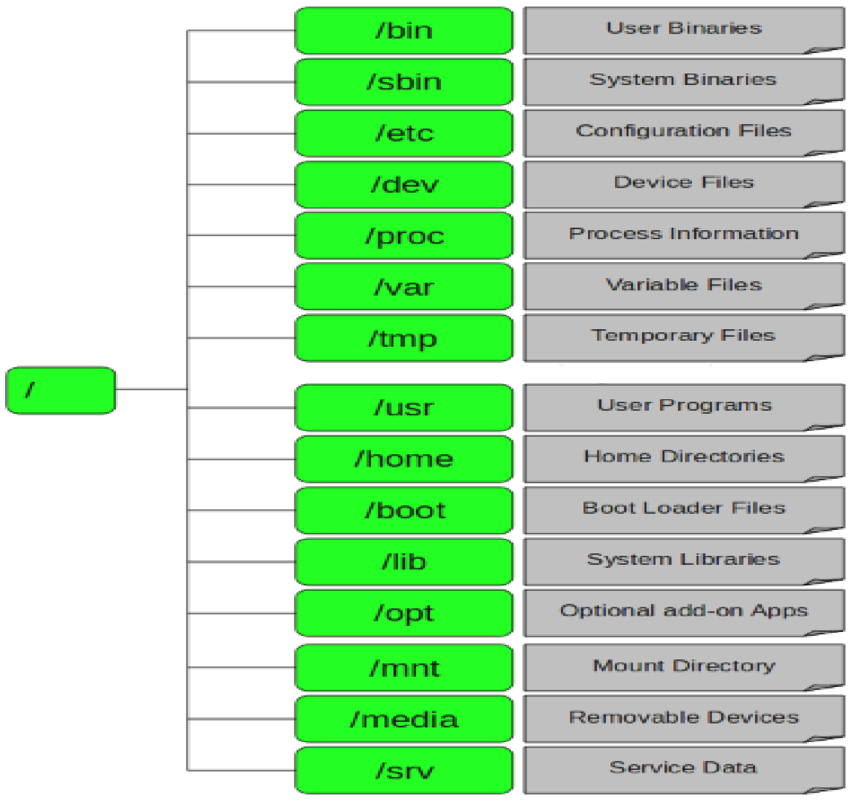
- The C shell was designed to allow users to write shell script programs using syntax very similar to that of the C programming language.
- The C shell is a UNIX shell created by Bill Joy.
- The C shell is a command processor typically run in a text window, allowing the user to type commands.
- Command full-path name is /bin/csh.
- Default prompt for a non-root user is hostname %.
- Default prompt for a root user is hostname #.

Bourne Again Shell (bash)

- The default Linux shell.
- Backward-compatible with the original sh UNIX shell.
- Bash is largely compatible with sh and incorporates useful features from the Korn shell ksh and the C shell csh.
- Command full-path name is /bin/bash.
- Default prompt for a non-root user is bash-x.xx$. (Where x.xx indicates the shell version number. For example, bash-3.50$)
- Root user default prompt is bash-x.xx#. (Where x.xx indicates the shell version number. For example, bash-3.50$#)

1) d) Study of Unix/Linux files system (tree structure).

- UNIX file system is a logical method of organizing and storing large amounts of information in a way that makes it easy to manage.
- All data in UNIX is organized into files. All files are organized into directories. These directories are organized into a tree-like structure called the file system.
- A file is a smallest unit in which the information is stored.
- Files in Unix System are organized into multi-level hierarchy structure known as a directory tree. At the very top of the file system is a directory called "root" which is represented by a "/". All other files are "descendants" of root.



1. / – Root

- Every single file and directory starts from the root directory.
- Only root user has write privilege under this directory.
- Please note that /root is root user's home directory, which is not same as /.

2. /bin – User Binaries

- Contains binary executables.
- Common linux commands you need to use in single-user modes are located under this directory.
- Commands used by all the users of the system are located here.

For example: ps, ls, ping, grep, cp.

3. /sbin – System Binaries

- Just like /bin, /sbin also contains binary executables.
- But, the linux commands located under this directory are used typically by system aministrator, for system maintenance purpose.

For example: iptables, reboot, fdisk, ifconfig, swapon

4. /etc – Configuration Files

- Contains configuration files required by all programs.
- This also contains startup and shutdown shell scripts used to start/stop individual programs.

For example: /etc/resolv.conf, /etc/logrotate.conf

5. /dev – Device Files

- Contains device files.
- These include terminal devices, usb, or any device attached to the system.

For example: /dev/tty1, /dev/usbmon0

6. /proc – Process Information

- Contains information about system process.
- This is a pseudo filesystem contains information about running process. For example: /proc/{pid} directory contains information about the process with that particular pid.
- This is a virtual filesystem with text information about system resources.

For example: /proc/uptime

7. /var – Variable Files

- var stands for variable files.
- Content of the files that are expected to grow can be found under this directory.
- This includes — system log files (/var/log); packages and database files (/var/lib); emails (/var/mail); print queues (/var/spool); lock files (/var/lock); temp files needed across reboots (/var/tmp);

8. /tmp – Temporary Files

- Directory that contains temporary files created by system and users.
- Files under this directory are deleted when system is rebooted.

9. /usr – User Programs

- Contains binaries, libraries, documentation, and source-code for second level programs.
- /usr/bin contains binary files for user programs. If you can’t find a user binary under /bin, look under /usr/bin. For example: at, awk, cc, less, scp
- /usr/sbin contains binary files for system administrators. If you can’t find a system binary under /sbin, look under /usr/sbin. For example: atd, cron, sshd, useradd, userdel
- /usr/lib contains libraries for /usr/bin and /usr/sbin
- /usr/local contains users programs that you install from source.

For example, when you install apache from source, it goes under /usr/local/apache2

10. /home – Home Directories

- Home directories for all users to store their personal files.

For example: /home/john, /home/nikita

11. /boot – Boot Loader Files

- Contains boot loader related files.
- Kernel initrd, vmlinux, grub files are located under /boot

For example: initrd.img-2.6.32-24-generic, vmlinuz-2.6.32-24-generic

12. /lib – System Libraries

- Contains library files that supports the binaries located under /bin and /sbin
- Library filenames are either ld* or lib*.so.*

For example: ld-2.11.1.so, libncurses.so.5.7

13. /opt – Optional add-on Applications

- opt stands for optional.
- Contains add-on applications from individual vendors.
- Add-on applications should be installed under either /opt/ or /opt/ sub-directory.

14. /mnt – Mount Directory

- Temporary mount directory where sysadmins can mount filesystems.

15. /media – Removable Media Devices

- Temporary mount directory for removable devices.

For examples, /media/cdrom for CD-ROM; /media/floppy for floppy drives; /media/cdrecorder for CD writer

16. /srv – Service Data

- srv stands for service.
- Contains server specific services related data.

For example, /srv/cvs contains CVS related data.

1) e) Study of .bashrc, /etc/bashrc and Environment variables.

.bashrc:

- A .bashrc file is automatically executed when new terminal (shell) is opened.
- Purpose of .bashrc file:
- You can export environment variables(So there is no need to export environment variable every time)
- You can define aliases
- You can provide the path for cross compiler
- You can add your own script which can start automatically whenever new shell is opened.
- You can change the history length.

/etc/bashrc:

- A .bashrc file exists in your home directory. This file is meant for setting command aliases and functions used by bash shell users.
- The /etc/bashrc for Red Hat and /etc/bash.bashrc in Ubuntu is the system wide version of .bashrc.
- Interestingly enough in the Red Hat implementation the /etc/bashrc also executes the shell scripts within /etc/profile.d but only if the users shell is an Interactive Shell (aka Login Shell)
- In Linux you can have two types of login shells, Interactive Shells and Non-Interactive Shells. An Interactive shell is used where a user can interact with the shell, i.e. your typical bash prompt. Whereas a non-Interactive shell is used when a user cannot interact with the shell, i.e. a bash scripts execution.
- The /etc/bashrc is executed for both interactive and non-interactive shells

```
# grep TEST /etc/bash.bashrc
export TESTBASHRC=1
```

ENVIRONMENT VARIABLES:

- Linux environment variables act as placeholders for information stored within the system that passes data to programs launched in shells or sub-shells.
- Admin's have the ability to modify environment variables to fit personal or larger group needs of users within their environments. As you'll notice below, admins can alter the hostname, command-line prompt, coloring in shells for text, and various other environment variables to better suit user preference.

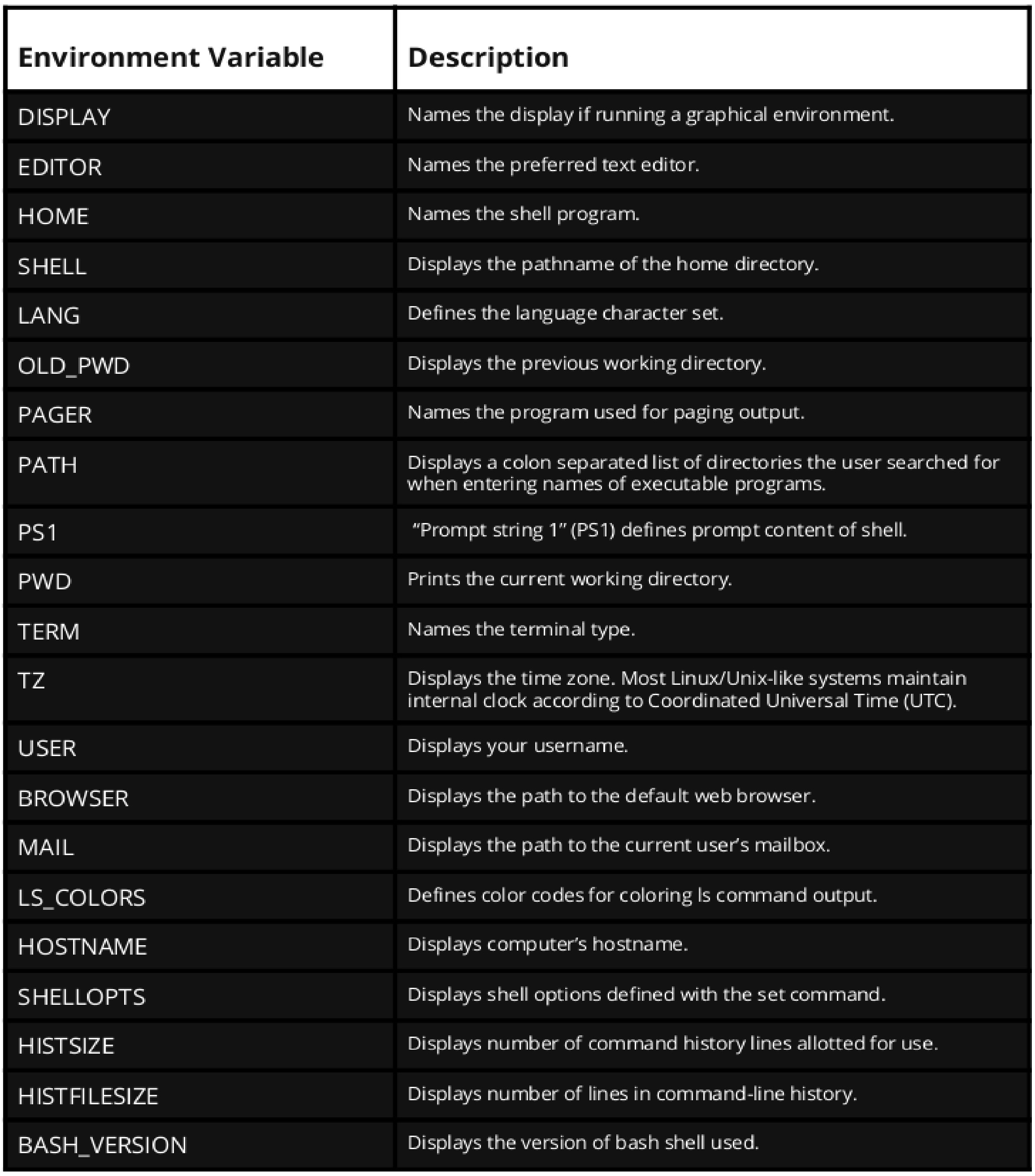
Commands for Environment Variables

1. env – The command lists all of the environment variables in the shell.
2. printenv – The command prints all (if no environment variable is specified) of environment variables and definitions of the current environment.
3. set – The command assigns or defines an environment variable.
4. unset – The command deletes the environment variable.
5. export – The command exports the value of the newly assigned environment variable.

Persistent and Non-persistent Environment Variables

- When modifying environment variables in your current shell, those variables remain non-persistent. The changes stay temporary and vanish once you log out of the shell.
- You can modify the variables to stay persistent by editing the bash configuration files. After you logout of the current shell, those changes remain intact and permanent for the user(s) or groups.

Common Environment Variables



Environment Variable	Description
DISPLAY	Names the display if running a graphical environment.
EDITOR	Names the preferred text editor.
HOME	Names the shell program.
SHELL	Displays the pathname of the home directory.
LANG	Defines the language character set.
OLD_PWD	Displays the previous working directory.
PAGER	Names the program used for paging output.
PATH	Displays a colon separated list of directories the user searched for when entering names of executable programs.
PS1	"Prompt string 1" (PS1) defines prompt content of shell.
PWD	Prints the current working directory.
TERM	Names the terminal type.
TZ	Displays the time zone. Most Linux/Unix-like systems maintain internal clock according to Coordinated Universal Time (UTC).
USER	Displays your username.
BROWSER	Displays the path to the default web browser.
MAIL	Displays the path to the current user's mailbox.
LS_COLORS	Defines color codes for coloring ls command output.
HOSTNAME	Displays computer's hostname.
SHELLOPTS	Displays shell options defined with the set command.
HISTSIZE	Displays number of command history lines allotted for use.
HISTFILESIZE	Displays number of lines in command-line history.
BASH_VERSION	Displays the version of bash shell used.

2. Write a C program that makes a copy of a file using standard I/O, and system calls

```
#include <stdio.h>
#include <unistd.h>
#include <fcntl.h>
void typefile (char *filename)
{
int fd, nread;
char buf[1024];
fd = open (filename, O_RDONLY);
if (fd == -1) {
perror (filename);
return;
}
while ((nread = read (fd, buf, sizeof (buf))) > 0)
write (1, buf, nread);
close (fd);
}
int main (int argc, char **argv)
{
int argno;
for (argno = 1; argno<argc; argno++)
typefile (argv[argno]);
}
```

OUTPUT:

```
$cc linux2.c
$cat>file1
Hi hello
$./a.out file1
Hi hello
```

3. Write a C program to emulate the UNIX ls –l command.

```
#include <stdio.h>
#include <unistd.h>
#include <sys/types.h>
#include <sys/wait.h>
#include <stdlib.h>
int main()
{
int pid;                              //process id
pid = fork();                         //create another process
if ( pid< 0 )
{                                     //fail
printf(“\nFork failed\n”);
exit (-1);
}
else if ( pid == 0 )
{                                     //child
execlp ( “/bin/ls”, “ls”, “-l”, NULL ); //execute ls
}
else
{                                     //parent
wait (NULL);                          //wait for child
printf(“\nchild complete\n”);
}
```

OUTPUT:

```
$cc linux3.c
$./a.out
-rw-r- - r- -file1
-rw-r- - r- -file2
-rw-r- - r- -file3
-rw-r- - r- -file4
Child completed
```

4. Write a C program that illustrates how to execute two commandsconcurrently with a command pipe. Ex: - ls –l | sort

```
#include <stdio.h>
#include <unistd.h>
#include <sys/types.h>
#include <stdlib.h>
int main()
{
int pfds[2];
char buf[30];
if(pipe(pfds)==-1)
{
perror(&quot;pipe failed&quot;);
exit(1);
}
if(!fork())
{
close(1);
dup(pfds[1]);
system (&quot;ls -l&quot;);
}
else
{
printf(&quot;parent reading from pipe \n&quot;);
while(read(pfds[0],buf,80))
printf(&quot;%s \n&quot; ,buf);
}
}
```

OUTPUT:

```
parent reading from pipe
total 16
-rwxr-xr-x 1 14100 14100 9082 Jun 23 04:40 a.out
-rwxrwxrwx 1 root roo
t 693 Jun 23 04:40 main.c
14100 9082 Jun 23 04:40 a.out
-rwxrwxrwx 1 root roo
```

5. Simulate the following CPU scheduling algorithms

a) Round Robin

```
#include<stdio.h>
#include<conio.h>
main()
{
int st[10],bt[10],wt[10],tat[10],n,tq;
int i,count=0,swt=0,stat=0,temp,sq=0;
float awt=0.0,atat=0.0;
clrscr();
printf("Enter number of processes:");
scanf("%d",&n);
printf("Enter burst time for sequences:");
for(i=0;i<n;i++)
{
scanf("%d",&bt[i]);
st[i]=bt[i];
}
printf("Enter time quantum:");
scanf("%d",&tq);
while(1)
{
for(i=0,count=0;i<n;i++)
{
temp=tq;
if(st[i]==0)
{
count++;
continue;
}
if(st[i]>tq)
st[i]=st[i]-tq;
else
if(st[i]>=0)
{
temp=st[i];
st[i]=0;
}
sq=sq+temp;
tat[i]=sq;
}
if(n==count)
break;
}
for(i=0;i<n;i++)
{
wt[i]=tat[i]-bt[i];
swt=swt+wt[i];
stat=stat+tat[i];
}
awt=(float)swt/n;
atat=(float)stat/n;
printf("Process_no \t Burst time \t Wait time \t Turn around time\n");
for(i=0;i<n;i++)
printf("%d \t%d \t%d \t%d\n",i+1,bt[i],wt[i],tat[i]);
printf("Avg wait time is %f \n Avg turn around time is %f",awt,atat);
getch();
}
```

OUTPUT:

Enter number of processes: 3
Enter burst time for sequences: 24 3 3
Enter time quantum: 4

Process_no	Burst time	Wait time	Turnaround time
1	24	6	30
2	3	4	7
3	3	7	10

Avg wait time is 5.666667
Avg turn around time is 15.666667

5) b) SJF (Shortest Job First)

```
#include<conio.h>
#include<stdio.h>
void main()
{
int i, j, n, process[10], total=0, wtime[10], ptime[10], temp, ptemp;
float avg=0;
clrscr();
printf("\nEnter number of Processes:");
scanf("%d", &n);
for(i=0;i<n;i++)
{
printf("\nEnter Process %d ID:",i+1);
scanf("%d", &process[i]);
printf("\nEnter Process %d Time:",i+1);
scanf("%d",&ptime[i]);
}
for(i=0;i<n-1;i++)
{
for(j=i+1;j<n;j++)
{
if(ptime[i]>ptime[j])
{
temp = ptime[i];
ptime[i] = ptime[j];
ptime[j] = temp;
ptemp = process[i];
process[i] = process[j];
process[j] = ptemp;
}
}
}
wtime[0]=0;
for(i=1;i<n;i++)
{
wtime[i]=wtime[i-1]+ptime[i-1];
total=total+wtime[i];
}
avg=(float)total/n;
printf("\nP_ID\t P_TIME\t W_TIME\n");
for(i=0;i<n;i++)
printf("%d\t %d\t %d\n",process[i],ptime[i],wtime[i]);
printf("\nTotal Waiting Time: %d \nAverage Waiting Time: %f", total, avg);
getch();
}
```

OUTPUT:

```
Enter number of Processes: 4
Enter Process 1 ID: 1
Enter Process 1 Time: 6
Enter Process 2 ID: 2
Enter Process 2 Time: 8
Enter Process 3 ID: 3
Enter Process 3 Time: 7
Enter Process 4 ID: 4
Enter Process 4 Time: 3
```

P_ID	P_TIME	W_TIME
4	3	0
1	6	3
3	7	9
2	8	16

```
Total Waiting Time: 28
Average Waiting Time: 7.000000
```

5) c) FCFS (First Come First Serve)

```
#include<stdio.h>
void main()
{
int i,n,sum,wt,tat,twt,ttat;
int t[10];
float awt,atat;
clrscr();
printf("Enter number of processors:\n");
scanf("%d",&n);
for(i=0;i<n;i++)
{
printf("\n Enter the Burst Time of the process %d",i+1);
scanf("\n %d",&t[i]);
}
printf("\n\n FIRST COME FIRST SERVE SCHEDULING ALGORITHM \n");
printf("\n Process ID \t Waiting Time \t Turn Around Time \n");
printf("1 \t\t 0 \t\t %d \n",t[0]);
sum=0;
twt=0;
ttat=t[0];
for(i=1;i<n;i++)
{
sum+=t[i-1];
wt=sum;
tat=sum+t[i];
twt=twt+wt;
ttat=ttat+tat;
printf("\n %d \t\t %d \t\t %d",i+1,wt,tat);
printf("\n\n");
}
awt=(float)twt/n;
atat=(float)ttat/n;
printf("\n Average Waiting Time %4.2f",awt);
getch();
}
```

OUTPUT:

Enter number of processors:3

Enter the Burst Time of the process: 124

Enter the Burst Time of the process: 23

Enter the Burst Time of the process: 33

FIRST COME FIRST SERVE SCHEDULING ALGORITHM

Process ID	Waiting Time	Turn Around Time
1	0	24
2	24	27
3	27	30

Average Waiting Time: 17.00

Average Turnaround Time: 27.00

d) Priority Scheduling Algorithm

```
#include <stdio.h>
#include <conio.h>
void main()
{
int i,j,n,tat[10],wt[10],bt[10],pid[10],pr[10],t,twt=0,ttat=0;
float awt,atat;
clrscr();
printf("\n-----------PRIORITY SCHEDULING--------------\n");
printf("Enter the No of Process: ");
scanf("%d", &n);
for (i=0;i<n;i++)
{
pid[i] = i;
printf("Enter the Burst time of Pid_%d : ",i);
scanf("%d",&bt[i]);
printf("Enter the Priority of Pid_%d : ",i);
scanf ("%d",&pr[i]);
}
for (i=0;i<n;i++)
for(j=i+1;j<n;j++)
{
if (pr[i] > pr[j] )
{
t = pr[i];
pr[i] = pr[j];
pr[j] = t;
t = bt[i];
bt[i] = bt[j];
bt[j] = t;
t = pid[i];
pid[i] = pid[j];
pid[j] = t;
}
}
tat[0] = bt[0];
wt[0] = 0;
for (i=1;i<n;i++)
{
```

```
wt[i] = wt[i-1] + bt[i-1];
tat[i] = wt[i] + bt[i];
}
printf("\n-------------------------------------------------------------\n");
printf("Pid\t Priority\tBurst time\t WaitingTime\tTurnArroundTime\n");
printf("\n-------------------------------------------------------------\n");
for(i=0;i<n;i++)
{
printf("\n%d\t\t%d\t%d\t\t%d\t\t%d",pid[i],pr[i],bt[i],wt[i],tat[i]);
}
for(i=0;i<n;i++)
{
ttat = ttat+tat[i];
twt = twt + wt[i];
}
awt = (float)twt / n;
atat = (float)ttat / n;
printf("\n\nAvg.Waiting Time: %f\nAvg.Turn Around Time: %f\n",awt,atat);
getch();
}
```

OUTPUT:

```
-----------PRIORITY SCHEDULING--------------
Enter the No of Process: 5
Enter the Burst time of Pid_0: 10
Enter the Priority of Pid_0: 3
Enter the Burst time of Pid_1: 1
Enter the Priority of Pid_1: 1
Enter the Burst time of Pid_2: 2
Enter the Priority of Pid_2: 4
Enter the Burst time of Pid_3: 1
Enter the Priority of Pid_3: 5
Enter the Burst time of Pid_4: 5
Enter the Priority of Pid_4: 2
```

```
--------------------------------------------------------------------------------------------
Pid     Priority        Burst time      WaitingTime         TurnArroundTime
--------------------------------------------------------------------------------------------
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
--------------------------------------------------------------------------------------------
Avg.Waiting Time: 8.200000
Avg.Turn around Time: 12.000000
```

6. Multiprogramming-Memory management-Implementation of fork (), wait (), exec() and exit (), System calls

```
#include <stdio.h>
#include <stdlib.h>
#include <unistd.h> /* for fork */
#include <sys/types.h> /* for pid_t */
#include <sys/wait.h> /* for wait */
int main(int argc,char** argv)
{/*Spawn a child to run the program.*/
pid_t pid=fork();
if (pid==0)
{ /* child process */
execv("/bin/ls",argv);
exit(127); /* only if execv fails */
}
else
{ /* pid!=0; parent process */
printf("\nWaiting Child process to finish");
//waitpid(pid,0,0); /* wait for child to exit */wait(NULL);
}
printf("\nExiting main process\n");
return 0;
}
```

OUTPUT:

```
$os509 $cc multiprogramming.c
$os509 $./a.out
Total 28
rwxrwxrx 1 staff2 staff2 7317 aug14 09:22 a.out
-
Rwxrwxr x 1 staff2 staff2 7317 aug14 09:16 multiprogramming
-
rwxrwxrx 1 staff2 staff2 361 aug16 09:20 multiprogramming.c
-
rwxrwxrx 1 staff2 staff2 359 aug14 09:16 multiprogramming.c
-
rwxrwxrx 1 staff2 staff2 1320 aug14 09:18 multiprogramming.c
Waiting until child process is finished
End  of main() process
```

7) a) Multiprogramming with a fixed number of tasks (MFT)

```
#include<stdio.h>
#include<conio.h>
main()
{
int ms, bs, nob, ef,n, mp[10],tif=0;
int i,p=0;
clrscr();
printf("Enter the total memory available (in Bytes) -- ");
scanf("%d",&ms);
printf("Enter the block size (in Bytes) -- ");
scanf("%d", &bs);
nob=ms/bs;
ef=ms - nob*bs;
printf("\nEnter the number of processes -- ");
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\t ALLOCATED\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%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
```

7) b) Multiprogramming with a variable number of tasks (MVT)

```
#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\t MEMORY 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("\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
```

8. Simulate Bankers Algorithm for Dead Lock Avoidance

```
#include<stdio.h>
int max[100][100];
int alloc[100][100];
int need[100][100];
int avail[100];
int n,r;
void input();
void show();
void cal();
int main()
{
int i,j;
printf("********** Banker's Algorithm ************\n");
input();
show();
cal();
return 0;
}
void input()
{
int i,j;
printf("Enter the no of Processes\t");
scanf("%d",&n);
printf("Enter the no of resources instances\t");
scanf("%d",&r);
printf("Enter the Max Matrix\n");
for(i=0;i<n;i++)
{
for(j=0;j<r;j++)
{
scanf("%d",&max[i][j]);
}
}
printf("Enter the Allocation Matrix\n");
for(i=0;i<n;i++)
{
for(j=0;j<r;j++)
{
```

```
scanf("%d",&alloc[i][j]);
}
}
printf("Enter the available Resources\n");
for(j=0;j<r;j++)
{
scanf("%d",&avail[j]);
}
}
void show()
{
int i,j;
printf("Process\t Allocation\t Max\t Available\t");
for(i=0;i<n;i++)
{
printf("\nP%d\t ",i+1);
for(j=0;j<r;j++)
{
printf("%d ",alloc[i][j]);
}
printf("\t");
for(j=0;j<r;j++)
{
printf("%d ",max[i][j]);
}
printf("\t");
if(i==0)
{
for(j=0;j<r;j++)
printf("%d ",avail[j]);
}
}
}
void cal()
{
int finish[100],temp,need[100][100],flag=1,k,c1=0;
int safe[100];
int i,j;
for(i=0;i<n;i++)
```

```
{
finish[i]=0;
}
//find need matrix
for(i=0;i<n;i++)
{
for(j=0;j<r;j++)
{
need[i][j]=max[i][j]-alloc[i][j];
}
}
printf("\n");
while(flag)
{
flag=0;
for(i=0;i<n;i++)
{
int c=0;
for(j=0;j<r;j++)
{
if((finish[i]==0)&&(need[i][j]<=avail[j]))
{
c++;
if(c==r)
{
for(k=0;k<r;k++)
{
avail[k]+=alloc[i][j];
finish[i]=1;
flag=1;
}
printf("P%d->",i);
if(finish[i]==1)
{
i=n;
}
}
}
}
}
}
for(i=0;i<n;i++)
{
if(finish[i]==1)
{
c1++;
}
else
{
printf("P%d->",i);
}
}
if(c1==n)
{
printf("\n The system is in safe state");
}
else
{
printf("\n Process are in dead lock");
printf("\n System is in unsafe state");
}
}
```

<u>OUTPUT:</u>

```
Enter the no of processes 5
Enter the no of resources instances 3
Enter the max matrix
7 5 3
3 2 2
9 0 2
2 2 2
4 3 3
Enter the allocation matrix
0 1 0
2 0 0
3 0 2
2 1 1
0 0 2
```

```
Enter available resources 3 2 2
P1->p3->p4->p2->p0->
The system is in safe state
```

9. **Simulate Bankers Algorithm for Dead Lock Prevention**

```
#include<stdio.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;
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!!");

}
```

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!!
```

10. Write a program to simulate page replacement algorithm for FIFO

```
#include<stdio.h>
int main()
{
int i,j,n,a[50],frame[10],no,k,avail,count=0;
            printf("\nenter the length of the Reference string:\n");
   scanf("%d",&n);
            printf("\n enter the reference string:\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\n");
       }
                        printf("Page Fault Is %d",count);
                        return 0;
}
```

INPUT:-

```
enter the length of the Reference string:20
enter the reference string:
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
```

OUTPUT:

```
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
--------------------------------
Process exited after 38.24 seconds with return value 0
Press any key to continue . . .
```

10) b) Write a program to simulate page replacement algorithm for LRU

```
#include<stdio.h>
main()
{
int i,j,m,n,a[20],p[20],f,pf=0,pos;
printf("enter number of pages\n");
scanf("%d",&m);
printf("enter number of pageframes\n");
scanf("%d",&n);
printf("enter pages\n");
for(i=0;i<m;i++)
scanf("%d",&p[i]);
for(i=0;i<n;i++)
a[i]=-1;
printf("pagefaults for %d frames are\n",n);
for(i=0;i<m;i++)
{
f=0;
for(j=0;j<n;j++)
{
if(a[j]==p[i])
{
pos=j;
f=1;
break;
}
pos=0;
}
for(j=pos;j<n-1;j++)
a[j]=a[j+1];
a[j]=p[i];
if(f==0)
pf++;
printf("\na=");
for(j=0;j<n;j++)
printf("%3d",a[j]);
}
printf("\ntotal number of pagefaults are %d\n",pf);
}
```

INPUT:

```
Enter number of pages
5
Enter number of page frames
3
Enter pages
3
5
6
7
1
```

OUTPUT:

```
Page faults for 3 frames are
a=      -1 -1  3
a=      -1  3  5
a=      3  5  6
a=      5  6  7
a=      6  7  1
Totalnumbers of page faults are 5
```

10) c) Write a program to simulate page replacement algorithm for optimal by least recently

```
#include<stdio.h>
#include<conio.h>
int n,page[20],f,fr[20],i;
void display()
{
 for(i=0;i<f;i++)
 {
  printf("%d",fr[i]);
 }
 printf("\n");
}
void request()
{
 printf("enter no.of pages:");
 scanf("%d",&n);
 printf("enter no.of frames:");
 scanf("%d",&f);
 printf("enter no.of page no.s");
 for(i=0;i<n;i++)
 {
  scanf("%d",&page[i]);
 }
 for(i=0;i<n;i++)
 {
  fr[i]=-1;
 }
}
void replace()
{
 int j,flag=0,pf=0;
 int max,lp[10],index,m;
 for(j=0;j<f;j++)
 {
  fr[j]=page[j];
  flag=1;
  pf++;
  display();
 }
 for(j=f;j<n;j++)
 {
  flag=0;
  for(i=0;i<f;i++)
  {
   if(fr[i]==page[j])
   {
    flag=1;
    break;
   }
  }
  if(flag==0)
  {
   for(i=0;i<f;i++)
   lp[i]=0;
   for(i=0;i<f;i++)
   {
    for(m=j+1;m<n;m++)
    {
     if(fr[i]==page[m])
     {
      lp[i]=m-j;
      break;
     }
    }
   }
   max=lp[0];
   index=0;
   for(i=0;i<f;i++)
   {
    if(lp[i]==0)
    {
     index=i;
     break;
    }
    else
    {
     if(max<lp[i])
     {
      max=lp[i];
      index=i;
     }
    }
   }
   fr[index]=page[j];
   pf++;
   display();
  }
 }
 printf("page faults:%d",pf);
}
 main()
{

 request();
 replace();

}
```

INPUT:

```
enter no of pages 5
enter no of frames 3
enter no of ref str 1 2 3 4 5
```

OUTPUT:

```
1 -1 -1
1 2 -1
1 2 3
4 2 3
5 2 3
page faults :5
```

11) Simulate the following File allocation strategies

a) File name: SEQUENTIAL.C

```
#include<stdio.h>
#include<conio.h>
#include<process.h>
struct sequence
{
        char n[20];
        int i;

}s[20];
int create(int);
int del(int);
void display(int);
void main()
{
        int x=0,j=0;
        clrscr();
        while(1)
        {
                printf("1.creation\n2.delete\n3.display\n4.exit");
                printf("\nenter one option: ");
                scanf("%d",&x);
                switch(x)
                {
                        case 1: j=create(j);
                                break;
                        case 2: j=del(j);
                                break;
                        case 3: display(j);
                                break;
                        case 4: exit(1);
                        default : printf("wrong option");
                }
        }
}
int create(int j)
{
        int m,v;
        j++;
        w:printf("\nenter the file name:");
        scanf("%s",&s[j].n);
        m=1;
        while(m<j)
        {
                v=strcmp(s[j].n,s[m].n);
                if(v==0)
                {
                        printf("file is already exist\nplease enter another name");
                        goto w;
                }
                m++;
        }
        printf("\nenter field:");
        scanf("%d",&s[j].i);
        return(j);
}
int del(int j)
{
        j--;
        return(j);
}
void display(int j)
{
        int l;
        printf("filename\tfield");
        for(l=1;l<=j;l++)
                printf("\n%s\t\t%d\n",s[l].n,s[l].i);
}
```

OUTPUT:

```
1.creation
2.delete
3.display
4.exit
enter one option:1
enter the file name:1.c
enter field:1
```

```
1.creation
2.delete
3.display
4.exit
enter one option:1
enter the file name:2.c
enter field:2
1.creation
2.delete
3.display
4.exit
enter one option: 3
filename        field
1.c             1
2.c             2
1.creation
2.delete
3.display
4.exit
enter one option: 4
```

b) File name: INDEXED.C

```
#include<stdio.h>
#include<conio.h>
#include<string.h>
struct file
{
        char n[20];
        int fld,ind;
}s[20];
int no,i=-1,a,b,f,j=-1,fe,t;
char tem[20];
void create();
void display();
void del();
void main()
{
        clrscr();
        while(1)
        {
                printf("\n\nMenu");
                printf("\n1.create\n2.display\n3.delete\n4.exit");
                printf("\nenter your choice:");
                scanf("%d",&no);
                switch(no)
                {
                        case 1: create();
                                break;
                        case 2: display();
                                break;
                        case 3: del();
                                break;
                        case 4: exit(0);
                        default: printf("wrong choice");
                }
        }
}
void create()
{
        i++;
```

```
            printf("\nenter the name of the recoed:");
            scanf("%s",&s[i].n);
            printf("\nenter the index no:");
            scanf("%d",&s[i].ind);
            printf("\nenter the field no:");
            scanf("%d",&s[i].fld);
            j++;
}
void display()
{
            for(a=0;a<i;a++)
            {
                        for(b=0;b<i;b++)
                        {
                                    if(s[b].ind>s[b+1].ind)
                                    {
                                                t=s[b].ind;
                                                s[b].ind=s[b+1].ind;
                                                s[b+1].ind=t;
                                                strcpy(tem,s[b].n);
                                                strcpy(s[b].n,s[b+1].n);
                                                strcpy(s[b+1].n,tem);
                                                t=s[b].fld;
                                                s[b].fld=s[b+1].fld;
                                                s[b+1].fld=t;
                                    }
                                    else
                                                continue;
                        }
            }
             printf("\n ---------------------------------");
             printf("\n\t Index    Recordname     FieldNo");
             for(i=0;i<=j;i++)
             {
                        printf("\n\t%d\t",s[i].ind);
                        printf("\t%s",s[i].n);
                        printf("\t%d",s[i].fld);
             }
             i--;
```

```
        printf("\n ----------------------------------\n");
}
void del()
{
        int de,index=-1,k=0,l;
        if(i!=-1)
        {
                printf("enter index no to be deleted");
                scanf("%d",&de);
                index=de;
                while(s[k].ind!=de)
                {
                        k++;
                        printf("\n\t\t\t%d",k);
                }
                for(l=k;l<=j;l++)
                        s[l]=s[l+1];
                i--;
                j--;
                printf("\nindex no %d file is deleted",index);
        }
}
```

OUTPUT:

```
Menu
1.create
2.display
3.delete
4.exit
Enter your choice:1
enter the name of the recoed:a.java
enter the index no:0
enter the field no:1
Menu
1.create
2.display
3.delete
4.exit
Enter your choice:1
```

```
enter the name of the recoed:b.c
enter the index no:1
enter the field no:2
Menu
1.create
2.display
3.delete
4.exit
Enter your choice:2

 ---------------------------------
        Index    Recordname     FieldNo
       0              a.java  1
       1              b.c     2
 -----------------------------------
Menu
1.create
2.display
3.delete
4.exit
Enter your choice :4
```

c) File name: LINKED.C

```
#include<stdio.h>
#include<stdlib.h>
typedef struct
{
        int bno,flag,next;
}block;
block b[200],b1;
void main()
{
        int rnum();
        int i,n,s,s1,p[30],r,k[20];
        clrscr();
        printf("\nEnter number of programs:");
        scanf("%d",&n);
        printf("\nEnter the memory block request");
        for(i=1;i<=n;i++)
        {
                printf("\nEnter program requirement");
                scanf("%d",&p[i]);
        }
        for(i=1;i<=n;i++)
        {
                s=rnum();
                b[s].bno=0;
                b[s].flag=1;
                k[i]=0;
                r=p[i]-1;
                while(r!=0)
                {
                        s1=rnum();
                        b[s].next=s1;
                        b[s1].flag=1;
                        b[s1].bno=0;
                        s=s1;
                        r=r-1;
                }
                b[s1].next=NULL;
        }
        printf("\n Starting blocks for program");
        for(i=1;i<=n;i++)
                printf("\n%5d%5d",i,k[i]);
        printf("\n allocated blocks");
        for(i=1;i<=200;i++)
        {
                if(b[i].flag==1)
                        printf("\n%5d%5d",b[i].bno,b[i].next);
        }
}
int rnum()
{
        int k,i;
        for(i=1;i<=200;i++)
        {
                k=rand()%200;
                if(b[i].flag!=1)
                        break;
        }
        return k;
}
```

OUTPUT:

```
Enter number of programs:2
Enter the memory block request
Enter program requirement3
Enter program requirement4
 Starting blocks for program
    1    0
    2    0
 allocated blocks
    0  117
    0   56
    0  195
    0  182
    0  130
    0    0
    0    0
```

12. Write a C program that illustrates two processes communicating using shared memory.

```
#include<stdio.h>
#include<sys/types.h>
#include<sys/ipc.h>
#include<sys/shm.h>
Struct country
{
char name[30];
char capital_city [30];
char currency[30];
int population;
};
int main(intargc,char*argv[])
{
int shm_id;
char*shm_addr;
int*countries_num;
struct country*countries;
structshmid_dsshm_desc;
shm_id=shmget(100,2048,IPC_CREAT|IPC_EXCL\0600);
if(shm_id==-1){
perror("main:shmget:");
exit(1);
}
shm_addr=shmat(shm_id,NULL,0);
if(!shm_addr){
ierror("main:shmat:");
exit(1);
}
countries_num=(int*)shm_addr;
*countries_num=0;
countries=(struct country*)((void*)shm_addrsizeof(int));
strcpy(countries[0],name,"U.S.A");
strcpy(countries[0],capital_city,"WASHINGTON");
strcpy(countries[0],currency,"U.S.DOLLAR");
countries[0].population=250000000;
( countries_num) ;
strcpy(countries[1].name,"israel");
strcpy(countries[1].capital_city,”jerushalem”);
strcpy(countries[1].currency,”NEW ISRAEL SHEKED”);
countries[1].population=6000000;
(*countries_num) ;
strcpy(countries[2].name,”France”);
strcpy(countries[2].capital_city,”paris”);
strcpy(countries[2].currency,”Frank”);
countries[2].population=60000000;
(*countries_num) ;
for(i=0;i<(*countries_num);i )
{
printf(“country%d:\n”,i 1);
printf(“name:%d:\n”,i 1);
printf(“currency:%s:\n”,countries[i].currency);
printf(“population:%d:\n”,countries[i].population);
}
if(shmdt(shm_addr)==-1){
perror(“main:shmdt:”);
}
if(shmctl(shm_id,IPC_RMID,&SHM_DESC)==-1)
{
perror(“main:shmctl:”);
}
return 0;
}
```

OUTPUT:

```
$cc shared.c
$./a.out
Shared memory ID=65537 child pointer 3086680064
Child value =1
Shared memory ID=65537 child pointer 3086680064
Parent value=1
Parent value=42
Child value=42
```

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

```
#include<stdio.h>
int mutex=1,full=0,empty=2,x=0;
main()
{
int n;
void producer();
void consumer();
int wait(int);
int signal(int);
printf("\n1.PRODUCER\n2.CONSUMER\n3.EXIT\n");
while(1)
{
printf("\nENTER YOUR CHOICE:");
scanf("%d",&n);
switch(n)
{
case 1:         if((mutex==1)&&(empty!=0))
producer();
else
printf("BUFFER IS FULL");
break;
case 2:         if((mutex==1)&&(full!=0))
consumer();
else
printf("BUFFER IS EMPTY");
break;
case 3:         exit(0);
break;
}
}
}
int wait(int s)
{
return(--s);
}
int signal(int s)
{
```

```
return(++s);
}
void producer()
{
mutex=wait(mutex);
full=signal(full);
empty=wait(empty);
x++;
printf("\nproducer produces the item%d",x);
mutex=signal(mutex);
}
void consumer()
{
mutex=wait(mutex);
full=wait(full);
empty=signal(empty);
printf("\n consumer consumes item%d",x);
x--;
mutex=signal(mutex);
}
```

OUTPUT:

```
1.PRODUCER
2.CONSUMER
3.EXIT
Enter your choice: 1
producer produces the item1
Enter your choice: 1
producer produces the item2
Enter your choice: 1
BUFFER IS FULL
Enter your choice: 2
consumer consumes item2
Enter your choice: 2
consumer consumes item1
Enter your choice: 2
BUFFER IS EMPTY
Enter your choice: 3
```

14. Write C program to create a thread using pthreads library and let it run its function.

```
#include<stdio.h>
#include<stdlib.h>
#include<pthread.h>
void *mythread(void *vargp)
{
sleep(1);
printf("WELCOME TO PTHREADS LIBRARY\n");
return NULL;
}
int main()
{
pthread_tid;
printf("Before thread\n");
pthread_create(&id,NULL,mythread,NULL);
pthread_join(id,NULL);
printf("After thread\n");
exit(0);
}
```

OUTPUT:

```
$cc linux7.c
$./a.out
WELCOME TO PTHREADS LIBRARY
```

15. Write a C program to illustrate concurrent execution of threads using pthreads library.

```
#include<stdio.h>
#include<stdlib.h>
#include<pthread.h>
void *mythread1(void *vargp)
{
int i;
printf("THREAD1\n");
for(i=1;i<=10;i++)
printf("i=%d\n",i);
printf("Exit from Thread1\n");
return NULL;
}
void *mythread2(void *vargp)
{
int j;
printf("THREAD2 \n");
for(j=1;j<=10;j++)
printf("j=%d\n",j);
printf("Exit from Thread2\n");
return NULL;
}
int main()
{
pthread_tid;
printf("Before thread\n");
pthread_create(&id,NULL,mythread1,NULL);
pthread_create(&id,NULL,mythread2,NULL);
pthread_join(id,NULL);
pthread_join(id,NULL);
printf("After thread\n");
}
```

OUTPUT:

```
$cc linux8.c
$./a.out
thread 1
i=1
```

```
i=2
i=3
thread 2
j=1
j=2
j=3
j=4
j=5
j=6
j=7
j=8
i=4
i=5
i=6
i=7
i=8
i=9
i=10
Exit from thread1
J=9
J=10
Exit from thread2
```

Content Beyond Syllabus

1. Write a C program to implement Reader's Writers Problem:

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

/*
This program provides a possible solution for first readers writers problem using
mutex and semaphore.
I have used 10 readers and 5 producers to demonstrate the solution. You can always
play with these values.
*/

sem_t wrt;
pthread_mutex_t mutex;
int cnt = 1;
int numreader = 0;

void *writer(void *wno)
{
    sem_wait(&wrt);
    cnt = cnt*2;
    printf("Writer %d modified cnt to %d\n",(*((int *)wno)),cnt);
    sem_post(&wrt);

}
void *reader(void *rno)
{
    // Reader acquire the lock before modifying numreader
    pthread_mutex_lock(&mutex);
    numreader++;
    if(numreader == 1) {
        sem_wait(&wrt); // If this id the first reader, then it will block the writer
    }
    pthread_mutex_unlock(&mutex);
    // Reading Section
    printf("Reader %d: read cnt as %d\n",*((int *)rno),cnt);

    // Reader acquire the lock before modifying numreader
    pthread_mutex_lock(&mutex);
    numreader--;
    if(numreader == 0) {
        sem_post(&wrt); // If this is the last reader, it will wake up the writer.
    }
    pthread_mutex_unlock(&mutex);
}

int main()
{
    pthread_t read[10],write[5];
    pthread_mutex_init(&mutex, NULL);
    sem_init(&wrt,0,1);

    int a[10] = {1,2,3,4,5,6,7,8,9,10}; //Just used for numbering the producer and
consumer

    for(int i = 0; i < 10; i++) {
        pthread_create(&read[i], NULL, (void *)reader, (void *)&a[i]);
    }
    for(int i = 0; i < 5; i++) {
        pthread_create(&write[i], NULL, (void *)writer, (void *)&a[i]);
    }

    for(int i = 0; i < 10; i++) {
        pthread_join(read[i], NULL);
    }
    for(int i = 0; i < 5; i++) {
        pthread_join(write[i], NULL);
    }

    pthread_mutex_destroy(&mutex);
    sem_destroy(&wrt);

    return 0;

}
```

Output:

```
Reader 7: read cnt as 1
Reader 8: read cnt as 1
Reader 9: read cnt as 1
Reader 10: read cnt as 1
Writer 1 modified cnt to 2
Writer 2 modified cnt to 4
Writer 3 modified cnt to 8
Writer 4 modified cnt to 16
Writer 5 modified cnt to 32
Reader 1: read cnt as 32
Reader 2: read cnt as 32
Reader 3: read cnt as 32
Reader 5: read cnt as 32
Reader 6: read cnt as 32
Reader 4: read cnt as 32
```

2.Write a C program to implement Dining Philosophere’s problem:

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

#define N 5
#define THINKING 2
#define HUNGRY 1
#define EATING 0
#define LEFT (phnum + 4) % N
#define RIGHT (phnum + 1) % N

int state[N];
int phil[N] = { 0, 1, 2, 3, 4 };

sem_t mutex;
sem_t S[N];

void test(int phnum)
{
        if (state[phnum] == HUNGRY
                && state[LEFT] != EATING
                && state[RIGHT] != EATING) {
                // state that eating
                state[phnum] = EATING;

                sleep(2);

                printf("Philosopher %d takes fork %d and %d\n",
                                        phnum + 1, LEFT + 1, phnum + 1);

                printf("Philosopher %d is Eating\n", phnum + 1);

                // sem_post(&S[phnum]) has no effect
                // during takefork
                // used to wake up hungry philosophers
                // during putfork
                sem_post(&S[phnum]);
        }
}

// take up chopsticks
void take_fork(int phnum)
{
        sem_wait(&mutex);

        // state that hungry
        state[phnum] = HUNGRY;

        printf("Philosopher %d is Hungry\n", phnum + 1);

        // eat if neighbours are not eating
        test(phnum);

        sem_post(&mutex);

        // if unable to eat wait to be signalled
        sem_wait(&S[phnum]);

        sleep(1);
}

// put down chopsticks
void put_fork(int phnum)
{

        sem_wait(&mutex);

        // state that thinking
        state[phnum] = THINKING;

        printf("Philosopher %d putting fork %d and %d down\n",
                phnum + 1, LEFT + 1, phnum + 1);
        printf("Philosopher %d is thinking\n", phnum + 1);

        test(LEFT);
        test(RIGHT);

        sem_post(&mutex);
}

void* philosopher(void* num)
{
        while (1) {
                int* i = num;
                sleep(1);
                take_fork(*i);
                sleep(0);
                put_fork(*i);
        }
}

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

        // initialize the semaphores
        sem_init(&mutex, 0, 1);
        for (i = 0; i < N; i++)
                sem_init(&S[i], 0, 0);
        for (i = 0; i < N; i++) {
                // create philosopher processes
                pthread_create(&thread_id[i], NULL, philosopher, &phil[i]);
                printf("Philosopher %d is thinking\n", i + 1);
        }

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

Output:

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

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

Viva Questions

1) Explain the main purpose of an operating system?
2) List various types of Schedulers
3) Differentiate between Preemptive and Non-Preemptive Scheduling
4) State various Preemptive Scheduling Algorithms
5) Make a comparison between MFT and MVT
6) Define Deadlock
7) What are necessary conditions which can lead to a deadlock situation in a system?
8) State Banker's Deadlock Avoidance algorithm
9) Define FAT
10) What is demand paging?
11) List various System calls for Process Management
12) List various System calls for File Management
13) List various System calls for Memory Management
14) Define Virtual memory?
15) Define Waiting Time, Turnaround Time, Response time and Throughput
16) List drawbacks of FCFS.
17) Which is the Optimal Scheduling algorithm
18) What are the advantages of Round-Robin scheduling algorithm?
19) State the main difference between logical and physical address space.
20) What is the basic function of paging?
21) What is fragmentation?
22) Define Mutual Exclusion
23) Define Semaphores and Monitors
24) Explain the advantages of Indexed File Allocation strategy
25) Define Kernel and Shell