Ex. No. 4 **LINUX COMMANDS**

Date:

Aim:

a) Basics Commands

1. echo SRM → to display the string SRM
2. clear → to clear the screen
3. date → to display the current date and time
4. cal 2003 → to display the calendar for the year 2003cal 6 2003 → to display the calendar for the June-2003
5. passwd → to change password
6. free –m → to view the size of RAM in MBfree –g → to view the size of RAM in GB
7. df –h → to view the disk space available and used.
8. uptime → to view the system up time
9. bc → to open a basic calculator
10. ps → to view the current terminal running processes
11. history → to get the history of all the past commands
12. whoami → to know which user i am

b) Working with Files

1. ls → list files in the present working directory
   ls –l → list files with detailed information
   (long list)ls –a → list all files including the hidden files
   ls –r root → list the directory recursively
   ls –lh → list the current location content in human redable formatls –lt → to list the files based on modification time
   ls –li → to view the inode number of files and directorieslscpu → to view the system specifications

2. cat > f1 → to create a file (Press ^d to finish typing)

3. cat f1 → display the content of the file f1

4. wc f1 → list no. of characters, words & lines of a file f1wc –c f1 → list only no. of characters of file f1
   wc –w f1 → list only no. of words of file f1

   wc –l f1 → list only no. of lines of file f1

5. cp f1 f2 → copy file f1 into f2

6. mv f1 f2 → rename file f1 as f2

7. rm f1 → remove the file f1

8. head –5 f1 → list first 5 lines of the file f1tail –5 f1 → list last 5 lines of the file f1

c) Working with Directories

1. mkdir elias → to create the directory elias
2. cd elias → to change the directory as elias
3. rmdir elias → to remove the directory elias
4. pwd → to display the path of the present working directory
5. cd → to go to the home
   directorycd .. → to go to the parent
   directory
   cd - → to go to the previous working
   directorycd / → to go to the root directory

d) File name substitution

1. ls f? → list files start with 'f' and followed by any one character
2. ls *.c → list files with extension 'c'
3. ls [gpy]et → list files whose first letter is any one of the character g, p or y and followed by the word et
4. ls [a-d,l-m]ring → list files whose first letter is any one of the character from a to d and l to m and followed by the word ring.

e) I/O Redirection

1. Input redirection

   wc –l < ex1 → To find the number of lines of the file 'ex1'

2. Output redirection

   who > f2 → the output of 'who' will be redirected to file f2

3. cat >> f1 → to append more into the file f1

f) Piping

Syntax : Command1 | command2

Output of the command1 is transferred to the command2 as input. Finallyoutput of the command2 will be displayed on the monitor.

ex. cat f1 | more → list the contents of file f1 screen by screen head –6 f1 |tail –2 → prints the 5^{th} & 6^{th} lines of the file f1.

g) Environment variables

1. echo $HOME → display the path of the home directory
2. echo $PS1 → display the prompt string $
3. echo $PS2 → display the second prompt string (> symbol by default)
4. echo $LOGNAME → login name
5. echo $PATH → list of pathname where the OS searches for an executable file

h) File Permission

-- chmod command is used to change the access permission of a file.

Method-1

Syntax : chmod [ugo] [+/-] [rwxa] filename

u : user, g : group, o : others
+ : Add permission - : Remove the permission r : read, w : write, x : execute, a :all permissions

ex. chmod ug+rw f1
adding 'read & write' permissions of file f1 to both user and groupmembers.

Method-2

Syntax : chmod octnum file1

The 3 digit octal number represents as follows

- first digit -- file permissions for the user
- second digit -- file permissions for the group
- third digit -- file permissions for others

Each digit is specified as the sum of following
4 – read permission, 2 – write permission, 1

– executepermission ex. chmod 754 f1

it change the file permission for the file as follows

- read, write & execute permissions for the user ie; 4+2+1 = 7
- read, & execute permissions for the group members ie; 4+0+1 = 5
- only read permission for others ie; 4+0+0 = 4

QUESTIONS FOR PRACTICE:

Q1. Write a command to cut 5 to 8 characters of the file *f1*.

$

Q2. Write a command to display user-id of all the users in your system.

$

Q3. Write a command to paste all the lines of the file *f1* into single line

$

Q4. Write a command to cut the first field of file *f1* and second field of file *f2* andpaste intothe file *f3*.

$

Q5. Write a command to change all small case letters to capitals of file *f2*.

$

Q6. Write a command to replace all *tab* character in the file *f2* by **:**

$

Q7. Write a command to check whether the user j*udith* is available in yoursystem or not.(use grep)

$

Q8. Write a command to display the lines of the file *f1* starts with SRM.

$

Q9. Write a command to display the name of the files in the directory */etc/init.d* that contains the pattern *grep*.

$

Q10. Write a command to display the names of nologin users. (Hint: the command *nologin* is specified in the last filed of the file /etc/passwd for nologin users)

$

Q11. Write a command to sort the file /etc/passwd in descending order

$

Q12. Write a command to sort the file /etc/passwd by user-id numerically. (Hint :user-id is in 3rd field)

$

Q13. Write a command to sort the file *f2* and write the output into the file *f22*. Also eliminate duplicate lines.

$

Q14. Write a command to display the unique lines of the sorted file *f21*. Alsodisplay the number of occurrences of each line.

$

Q15. Write a command to display the lines that are common to the files *f1* and *f2*.

$

Result:

Ex. No. 5 **SYSTEM ADMIN COMMANDS**

Date:

Aim:

INSTALLING SOFTWARE

Procedure:

- Open the Ubuntu software Center.
- To install any package, open the terminal (Ctrl + Alt + T) and type sudo apt-get install <package name>.
- For instance, to get Chrome type sudo apt-get install chrome-browser.
- Likewise user can work package update, remove and reinstall the package using thefollowing commands.

To update the package repositories

```
sudo apt-get update
```

To update installed software

```
sudo apt-get upgrade
```

To install a package/software

```
sudo apt-get install  <package-name>
```

To remove a package from the system

```
sudo apt-get remove <package-name>
```

To reinstall a package

```
sudo apt-get install  <package-name> --reinstall
```

To completely remove a software and it's dependent packages run the apt-get purge

```
sudo apt-get purge <package-name>
```

To remove all Debian (.deb) files those are no longer installed
---files in /var/cache/apt/archives

```
sudo apt-get autoclean
```

To empty whole cache files – to reduce the space consumption

```
sudo apt-get clean
```

To remove old dependent files and footprints installed by previous applications

```
sudo apt-get automove
```

To configure installed package

```
sudo dpkg –configure –a
```

To download but not install package

```
sudoapt-get download <package-name>
```

MANAGING USERS

- Managing users is a critical aspect of server management.
- In Ubuntu, the root user is disabled for safety.
- Root access can be completed by using the sudo command by a user who is inthe "admin" group.
- When you create a user during installation, that user is added automatically to theadmin group.

To add a user:

```
sudo adduser username
```

To disable a user:

```
sudo passwd -l username
```

To enable a user:

```
sudo passwd -u username
```

To delete a user:

```
sudo userdel –r username
```

To create a group:

```
sudo addgroup groupname
```

To delete a group:

```
sudo delgroup groupname
```

To create a user with group:

```
sudo adduser username groupname
```

To see the password expiry value for a user,

```
sudo chage -l username
```

To make changes:

```
sudo chage username
```

GUI TOOL FOR USER MANAGEMENT

GUI Tool allow the admin to run the commands in terminal to manage users and groups.

To install a GUI add-on

```
sudo apt install gnome-system-tools
```

Once done, type

```
users-admin
```

MANAGING THE FILE SYSTEM

A filesystem is a permanent storage for containing data. Any non-volatile storage device like hard disk, usb etc has a filesystem in place, on top of which data is stored. While installing Linux, you may opt for either EXT4 or EXT3 file system.

Ext3 : A journaling filesystem: logs changes in a journal to increase reliability in case ofpower failure or system crash.

EXT4: It is an advanced file syste. This file system supports 64-bit storage limits, columnsup to 1 exabytes and you may store files up to 16 terabytes

Disk Partitions can be viewed by the command `sudo fdisk -l`

File system information are available in the file `/etc/fstab`

MANGING THE NETWORK CONFIGURATION

Most networking is configured by editing two files:

- `/etc/network/interfaces`
  - Ethernet, TCP/IP, bridging
- `/etc/resolv.conf`
  - DNS

Other networking files:

- `/etc/hosts`
- `/etc/dhcp3/dhcpd.conf`

To test any host's connectivity

```
ping <ip-address>
```

To start/stop/restart/reload networking services

```
sudo /etc/init.d/mnetworking <function>
```

Note : <function> can be any one of `stop` or `start` or `reload` or `restart`

To list of all active network interface cards, including wireless and the loopback interface

```
sudo ifconfig
```

To display host Fully Qualified Domain Name

```
sudo hostname
```

To display arp table (ip to mac resolution)

```
sudo arp –a
```

To remove entry from arp table

```
sudo arp –d <user name>
```

To display or change network card settings, use ethtool

```
sudo ethtool eth0
```

To displays extensive status information when queried with the service iptables status command

```
sudo service iptables status
```

To start/stop services

```
sudo service iptables start/stop
```

INSTALLING INTERNET SERVICES

Installing Apache server

```
sudo apt-get install apache2
```

Configuration file for Apache server

```
apache2.conf
```

Restart apache services after any configuration changes made

```
sudo /etc/init.d/mnetworking restart
```

Similarly all services can be installed, configured and restarted

MANAGING BACKGROUND JOBS

To display jobs running in background

```
sudo jobs
```

To check the process id of background processes

```
sudo jobs –p
```

To bring a background job to the foreground

```
sudo fg
```

To start the Jobs suspended in background

```
sudo bg
```

QUESTIONS FOR PRACTICE:

Q1. Update the package repositories

Q2. Install the package “simplescreenrecorder”

Q3. Remove the package “simplescreenrecorder”

Q4. Create a user ‘elias’. Login to the newly created user and exit.

Q5. Disable the user ‘elias’, try to login and enable again.

Q6. Create a group ‘cse’ and add the user ‘elias’ in that group

Q7. List the account expiry information of the user ‘elias’

Q8. Change the ‘Number of days warning before password expires’ as 5 for the user ‘elias’

Q9. Delete the user ‘elias’ and then delete the group ‘cse’

Q10. List the partitions available in your system

Q11. What are the file systems used in your system

Q12. Stop the networking service and then start the service

Q11. What are the file systems used in your system

Q12. Stop the networking service and then start the service

Q13. Check the connectivity of the host with IP address 127.0.0.1

Q14. Find the IP address of the localhost

Q15. Find the IP address of the DNS Server (name server)

Q16. Install mysql server

Q17. Restart mysql server

Q18. Check the configuration file for mysql server

Q19. Log on as root into mysql server

Q20. Create a new database for mysql server

Result:

Ex. No. 6 **SIMPLE TASK AUTOMATION**

Date:

Aim:

Crontab

Linux Cron utility is an effective way to schedule a routine background job at a specific time and/or day on an on-going basis. User can use this to schedule activities, either as one- time events or as recurring tasks.

Scheduling of Tasks (For Ubuntu)

Step 1 : Open terminal and type the command `crontab -e`

Step 2 : Choose the editor. Better to select

`nano` editorStep 3 : Edit the file based on the

syntax given above Step 4 : Save and Exit the

file

Step 5 : Start cron daemon using the following command

```
systemctl start cron
```

Linux Crontab Format

MIN HOUR DOM MON DOW CMD

Table: Crontab Fields and Allowed Ranges (Linux Crontab Syntax)

Field	Description	Allowed Value
MIN	Minute field	0 to 59
HOUR	Hour field	0 to 23
DOM	Day of Month	1-31
MON	Month field	1-12
DOW	Day Of Week	0-6
CMD	Command	Any command to be executed

Create a new crontab file, or edit an existing file

crontab -e [username]

where *username* specifies the name of the user's account for which you want to create or edita crontab file.

Verify your crontab file changes

crontab -l [username]

Install crontab

crontab -a filename

Edit the crontab

crontab -e

Display crontab

crontab -l

Display the last edit the crontab file

crontab -v

Remove crontab

crontab -r

Following are the syntax for cron

minute(s) hour(s) day(s) month(s) weekday(s) command(s) "Argument1"

"Argument2"1 * 3 4 5 /path/to/command arg1 arg2

If you don't have parameter
put star(*)Commands:

1) **-l** - List or manage the task with crontab command
2) **-e** - edit crontab entry.
3) **-u** - To list scheduled jobs of a particular user called **tecmint** using.
4) **-r** - parameter will remove complete scheduled jobs withoutconfirmation from crontab.
5) **-i** - prompt you confirmation from user before deleting user'scrontab.

Allowed special character (*, -, /, ?, #)

1. **Asterik(*)** – Match all values in the field or any possible value.
2. **Hyphen(-)** – To define range.
3. **Slash (/)** – 1st field /10 meaning every ten minute or increment of range.
4. **Comma (,)** – To separate items.

System Wide Cron Schedule

System administrator can use predefine cron directory as shown below.

1. /etc/cron.d
2. /etc/cron.daily
3. /etc/cron.hourly
4. /etc/cron.monthly
5. /etc/cron.weekly

To Schedule a Job for Specific Time

The below jobs delete empty files and directory from **/tmp** at **12:30** am daily.User need to mention user name to perform crontab command.
In below example **root** user is performing cron job.

crontab –e

30 0 * * * root find /tmp -type f -empty –delete

Special Strings for Common Schedule

Strings	**Meanings**
@reboot	Command will run when the system reboot.
@daily	Once per day or may use @midnight.
@weekly	Once per week.
@yearly	Once per year.user can use @annually keyword also.

Multiple Commands with Double ampersand (&&)

To run the command1 and command2 daily

crontab -e

@daily <command1> && <command2>

Disable Email Notification.

By default cron send mail to user account executing cronjob. If user want to disable using **>/dev/null2>&1** option at the end of the file will redirect all the output of the cron results under **/dev/null**.

[root@tecmint ~]# crontab -e

* * * * * >/dev/null 2>&1

Scheduling a Job for a Specific Time

The basic usage of cron is to execute a job in a specific time as shown below. This will executethe full backup shell script (full-backup) on **10th June 08:30 AM**.

The below time field uses 24 hours format. So, for 8 AM use 8, and for 8

PM use 20.30 08 10 06 * /home/username/full-backup

- **30** – 30th Minute
- **08** – 08 AM
- **10** – 10th Day
- **06** – 6th Month (June)
- ***** – Every day of the week

Schedule a Job for More Than One Instance (e.g. Twice a Day)

The following script takes a incremental backup twice a day every day. This example executes the specified incremental backup shell script (incremental-backup) at 11:00 and 16:00 on every day. Thecomma separated value in a field specifies that the command needs to be executed in all the mentioned time.

00 11,16 * * * /home/username/bin/incremental-backup

- **00** – 0th Minute (Top of the hour)
- **11,16** – 11 AM and 4 PM
- ***** – Every day
- ***** – Every month
- ***** – Every day of the week

Schedule a Job for Specific Range of Time (e.g. Only on Weekdays)

- To schedule the job for every hour with in a specific range of time then use the following.

Cron Job everyday during working hours

This example checks the status of the database everyday (including weekends) during theworking hours 9 a.m – 6 p.m

00 09-18 * * * /home/username/bin/check-db-status

- **00** – 0th Minute (Top of the hour)
- **09-18** – 9 am, 10 am,11 am, 12 am, 1 pm, 2 pm, 3 pm, 4 pm, 5 pm, 6 pm
- ***** – Every day
- ***** – Every month
- ***** – Every day of the week

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- ***** – Every day
- ***** – Every month
- ***** – Every day of the week

Schedule a Job for Every Minute Using Cron.

Ideally user may not have a requirement to schedule a job every minute. But understanding this examplewill help user understand the other examples mentioned below in this article.

* * * * * CMD

The * means all the possible unit — i.e every minute of every hour throughout the year. More than usingthis * directly, user will find it very useful in the following cases.

- When user specify */5 in minute field means every 5 minutes.
- When user specify 0-10/2 in minute field mean every 2 minutes in the first 10 minute.
- Thus the above convention can be used for all the other 4 fields.

Schedule a Background Cron Job For Every 10 Minutes.

Use the following, to check the disk space every 10 minutes.

*/10 * * * * /home/username/check-disk-space

It executes the specified command check-disk-space every 10 minutes throughout the year.

There are special cases in which instead of the above 5 fields you can use @ followed by a keyword —such as reboot, midnight, yearly, hourly.

Table: Cron special keywords and its meaning

Keyword	Equivalent
@yearly	0 0 1 1 *
@daily	0 0 * * *
@hourly	0 * * * *
@reboot	Run at startup.

Schedule a Job for First Minute of Every Year using @yearly

User can specify a job to be executed on the first minute of every year, then user can usethe **@yearly** cron keyword as shown below.

This will execute the system annual maintenance using annual-maintenance shell script at 00:00 on Jan1st for every year.

@yearly /home/username/red-hat/bin/annual-maintenance

Schedule a Cron Job Beginning of Every Month using @monthly

Executes the command monthly once using **@monthly** cron keyword.

This will execute the shell script tape-backup at 00:00 on 1st of every

month.@monthly /home/username/suse/bin/tape-backup

Schedule a Background Job Every Day using @daily

Using the @daily cron keyword, this will do a daily log file cleanup using cleanup-logs shell scriptat00:00 on every day.

@daily /home/username/arch-linux/bin/cleanup-logs "day started"

To Execute a Linux Command After Every Reboot using @reboot

Using the **@reboot** cron keyword, this will execute the specified command once after the machine gotbooted every time.

@reboot CMD

To Disable/Redirect the Crontab Mail Output using MAIL keyword

By default crontab sends the job output to the user who scheduled the job. To redirect the output to aspecific user, add or update the MAIL variable in the crontab as shown below.

username@dev-db$
crontab -l
MAIL="username"
@yearly /home/username/annual-maintenance
*/10 * * * * /home/username/check-disk-space
[Note: Crontab of the current logged in user with MAIL variable]

To stop the crontab output to be emailed, add or update the MAIL variable in the crontab as shownbelow.

MAIL=""

Specify PATH Variable in the Crontab

To set absolute path of the Linux command or the shell-script :

Instead of specifying /home/username/tape-backup, user can specify tape-backup, then add the path
/home/username to the PATH variable in the crontab as shown below.

username@dev-db$ crontab -l
PATH=/bin:/sbin:/usr/bin:/usr/sbin:/home/
username@yearly annual-maintenance
*/10 * * * * check-disk-space
[Note: Crontab of the current logged in user with PATH variable]

To Install Crontab from a Cron File

Instead of directly editing the crontab file, user can also add all the entries to a cron-file first.

Once userhave all thoese entries in the file, user can upload or install them to the cron as

shown below.username@dev-db$ crontab -l
no crontab for username
$ cat cron-file.txt
@yearly /home/username/annual-maintenance
*/10 * * * * /home/username/check-
disk-spaceusername@dev-db$
crontab cron-file.txt username@dev-
db$ crontab -l
@yearly /home/username/annual-maintenance
*/10 * * * * /home/username/check-disk-space

To View Crontab Entries:

View Current Logged-In User's
Crontab entriesTo view crontab entries
type
crontab -l

Username@dev-db$ crontab -l
@yearly /home/username/annual-maintenance

*/10 * * * * /home/username/check-disk-space

[Note: This displays crontab of the current logged in user]

To View Root Crontab entries

Login as root user (su – root) and do crontab -l as

shown below.root@dev-db# crontab -l

no crontab for root

To View Other Linux User's Crontabs entries:
To view crontab entries of other

Linux users,login to root and use **-u**

{username} -l

root@dev-db# crontab -u username
-l @monthly
/home/username/monthly-backup
00 09-18 * * * /home/username/check-db-status

To Edit Crontab Entries:

Edit Current Logged-In User's
Crontab entriesTo edit a crontab
entries,

use crontab –e

By default this will edit the current logged-in users

crontab.username@dev-db$ crontab -e

@yearly /home/username/centos/bin/annual-maintenance

*/10 * * * * /home/username/debian/bin/check-
disk-space"/tmp/crontab.XXXXyjWkHw" 2L,
83C

[Note: This will open the crontab file in Vim editor for editing.

Please note cron created a temporary /tmp/crontab.XX...]
When user save the above temporary file with :wq, it will save the crontab and display the followingmessage indicating the crontab is successfully modified.

QUESTIONS FOR PRACTICE:

Q1. Schedule a task to display the following message on the monitor for every 2 minutes.

Q2. Schedule a task to take backup of your important file (say file f1) for every 30 minutes

Q3. Schedule a task to take backup of login information everyday 9:30am

Result:

Ex. No. 7 **SHELL PROGRAMS**

Date:

Aim:

How to run a Shell Script

- Edit and save your program using editor
- Add execute permission by *chmod* command
- Run your program using the name of your program

```
./program-name
```

Important Hints

- No space before and after the assignment operator Ex. `sum=0`
- *Single quote* ignores all special characters. Dollar sign, Back quote and Back slash arenot ignored inside *Double quote*. *Back quote* is used as command substitution. *Back slash* is used to remove the special meaning of a character.
- Arithmetic expression can be written as follows : `i=$((i+1)` or `i=$(expr $i + 1)`
- Command line arguments are referred inside the program as `$1, $2`, ..and so on
- `$*` represents all arguments, `$#` specifies the number of arguments
- `read` statement is used to get input from input device. Ex. `read a b`

Syntax for if statement

```
if [ condition ]

then     …..

elif [condition]
then          ….


else
fi…….
```

Syntax for case structure

Case value in

Pat1) …

Statement;;

Pat2)…

Statement;;

*)…

Statement;;

esac

Syntax for printf statement

```
printf  "string and format"  arg1  arg2 … …
```

- Break and continue statements functions similar to C programming
- Relational operators are –lt, -le, -gt, -ge, -eq,-ne
- Ex. (i>= 10) is written as [$i -ge 10]
- Logical operators (and, or, not) are -o, -a, !
- Ex. (a>b) && (a>c) is written as [$a –gt $b –a $a –gt $c]
- Two strings can be compared using = operator

Q1. Given the following values

num=10, x=*, y=`date` `a="Hello, 'he said'"`

Execute and write the output of the following commands

Command	Output
echo num	
echo $num	
echo $x	
echo '$x'	
echo "$x"	
echo $y	
echo $(date)	
echo $a	
echo \$num	
echo \$$num	

Q2. Find the output of the following shell scripts

```
$ vi  ex51
echo Enter value for nread n
sum=0i=1
while [ $i –le $n ]do
              sum=$((sum+i))i=$((i+2))

done

echo Sum is $sum
```

Output :

Q3. Write a program to check whether the file has execute permission or not. If not,add thepermission.

```
$ vi ex52
```

Q4. Write a shell script to print a greeting as specified below.

If hour is greater than or equal to 0 (midnight) and less than or equal to 11 (up to 11:59:59),"Good morning" is displayed.

If hour is greater than or equal to 12 (noon) and less than or equal to 17 (up to 5:59:59p.m.), "Good afternoon" is displayed.

If neither of the preceding two conditions is satisfied, "Good evening" is displayed.

```
$ vi  ex53
  hour=$(date | cut -c12-13)
  if [ "$hour" -ge 0 -a "$hour" -le 11 ]
  then                                    ← complete the program
```

Q5. Write a shell script to list only the name of sub directories in the present workingdirectory

```
$ vi ex54
```

Q6. Write a program to check all the files in the present working directory for a pattern (passed through command line) and display the name of the file followed by a message stating that the pattern is available or not available.

```
$ vi ex55
```

Result:

Ex. No. 8 **PROCESS CREATION**

Date:

Aim:

Syntax for process creation

int fork();

Returns 0 in child process and child process ID in parent process.

Other Related Functions

int getpid() → returns the current process IDint getppid() → returns the parent process ID

wait() → makes a process wait for other process to complete

Virtual fork

vfork() function is similar to fork but both processes shares the same addressspace.

Q1. Find the output of the following program

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

int main()
{
int a=5,b=10,pid;

printf("Before fork a=%d b=%d \n",a,b);pid=fork();

if(pid==0)
{
a=a+1;b=b+1;
printf("In child a=%d b=%d \n",a,b);
}
else
{
sleep(1);a=a-1;
b=b-1;
printf("In Parent a=%d b=%d \n",a,b);
}
return 0;
      }
```

Output :-

Q2. Rewrite the program in Q1 using vfork() and write the output

Q3. Calculate the number of times the text "SRMIST" is printed.

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

int main()
{
        fork();
        fork();
        fork();
        printf("SRMIST\n");
        return 0;
}
```

Output:

Q4. Complete the following program as described below :
The child process calculates the sum of odd numbers and the parent process calculate the sum of even numbers up to the number 'n'. Ensure the Parent process waits for thechild process to finish.

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

int main()
{
int  pid,n,oddsum=0,evensum=0;

printf("Enter the value of n : ",a);
scanf("%d",&n);
pid=fork();
// Complete the program









return 0;
}
```

Sample Output :

Enter the value of n	10
Sum of odd numbers	25
Sum of even numbers	30

Q5. How many child processes are created for the following code?

Hint : Check with small values of 'n'.

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

Output :

Q6. Write a program to print the Child process ID and Parent process ID in bothChild and Parent processes

```
#include
<stdio.h>
#include<uni
std.h>int
main()
{
```

Sample Output:

```
In Child Process
Parent Process ID       :     18
Child Process ID        :     20

In Parent Process
Parent Process ID       :     18
Child Process ID        :     20
```

Q7. How many child processes are created for the following code?

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

int main()
{
    fork();
    fork()&&fork()||fork();fork
    ();printf("Yes ");
    return 0;

}
```

Output :

Result:

Ex. No. 9 & 10 **OVERLAY CONCEPTS**

Date:

Aim:

Overlay

Overlay is the concept which enables the user to run another new process from the currentlyrunning process address space.

System call used :

Exec() System Call

The exec() system call replaces (overwrites) the current process with the new process image. The PID of the new process remains the same however code, data, heap and stack of the process are replaced by the new program. There are 6 system calls in the family of exec(). All of these functions mentioned below are layered on top of execve(), and they differ from one another and from execve() only in the wayin which the program name, argument list, and environment of the new program are specified

Syntax:

```
int execl(const char* path, const char* arg, ...)
int execlp(const char* file, const char* arg, ...)
int execle(const char* path, const char* arg, ..., char* const envpl))
int execv(const char* path, const char* argv[])
int execvp(const char* file, const char* argv[])
```

int execvpe(const char* file, const char* argv[], char *const envpl])

- The names of the first five of above functions are of the form execXY.
- X is either 1 or v depending upon whether arguments are given in the list format (argo, argl, ...,NULL) or arguments are passed in an array (vector).

- Y is either absent or is either a p or an e. In case Y is p, the PATH environment variable is usedto search for the program. If Y is e, then the environment passed in envp array is used.
- In case of execvpe, X is v and Y is e. The execvpe function is a GNU extension. It is named so asto differentiate it from the execve system call.

Simple overlay concept
Procedure

- Stepl: Create two different c programs. Name it as example.c file and hello.c file
- Step2: Make example .c is the current running process,
- Step3: call the function execv() which takes the hello.c as an argument.
- Step4: Print process id of both the processes(hello.c and example.c processes).
- Step5: trace the system control by having simple print statement in both programs.

Expected Output:

$ process id of example.c=4733
We are in hello.c
Process id of hello.c=4733

COMBINING FORK() AND EXEC() SYSTEM CALL

Procedure:

- Stepl: Create two different c programs. Name it as example.c file and hello.c file
- Step2: Make example .c is the current running process and use fork() system call to create childprocess,
- Step3: call the function execv() in child process which takes the hello.c as an argument.
- Step4: Print Process id of both parent, child and overlay processes (hello.c and example.c processes).
- Step5: trace the system control by having simple print statement in both programs.

Expected Output:

$ process id of example.c=4790
The control is in parent process
The control is in child process Process id of child = 4791
Calling hello.c from child
We are in hello.c
Process id of hello.c=4791

PRACTICE QUESTIONS:

1. Execute the Following Program and write the output

```
$vi  ex1.c.
#include <stdio.h>
#include <unistd.h>
int main()
printf("Transfer to execlp function \n");
execlp("head", "head","-2","fl",NULL); // Assume fl is any text file
printf("This line will not execute \n");
return 0;
```

Output :

Why second printf statement is not executing?

2. Rewrite question 1 with execl() function. Pass the 3rd and 4th argument of the function execl() through command line arguments.

Input : /a.out -3 fi

Output:

Result:

Ex. No. 11 **INTER PROCESS COMMUNICATION – PIPE( )**

Date:

Aim:

Inter Process Communication (IPC):

A process can be of two types:

- Independent process.
- Co-operating process.

An independent process is not affected by the execution of other processes while a co operating processcan be affected by other executing processes.

Inter process communication (IPC) is a mechanism which allows processes to communicate with each other and synchronize their actions. The communication between these processes can be seen as a method of co-operation between them. Processes can communicate with each other through both:

- Shared Memory
- Message passing

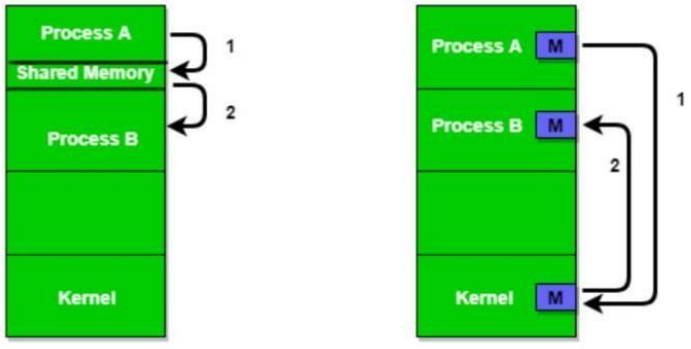


Figure 1 - Shared Memory and Message Passing

Inter process communication (IPC) is used for exchanging data between multiple threads in one or more processes or programs. The Processes may be running on single or multiple computers connected by a network. The full form of IPC is Inter-process communication.

It is a set of programming interface which allow a programmer to coordinate activities among various program processes which can run concurrently in an operating system. This allows a specific program to handle many user requests at the same time.

Since every single user request may result in multiple processes running in the operating system, the process may require to communicate with each other. Each IPC protocol approach has its own advantage and limitation, so it is not unusual for a single program to use all of the IPC methods.

Important methods for inter process communication:

Pipes

Pipe is widely used for communication between two related processes. This is a half-duplex method, so the first process communicates with the second process. However, in order to achieve a full- duplex, another pipe is needed.

Message Passing:

It is a mechanism for a process to communicate and synchronize. Using message passing, theprocess communicates with each other without resorting to shared variables.

IPC mechanism provides two operations:

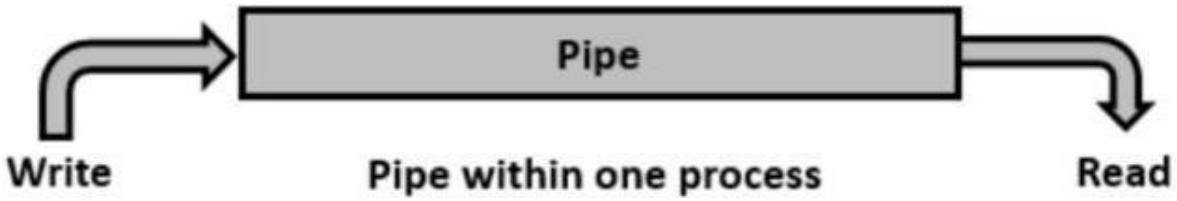
- Send (message)- message size fixed or variable
- Received (message)

Message Queues:

A message queue is a linked list of messages stored within the kernel. It is identified by a message queue identifier. This method offers communication between single or multiple processes with full-duplexcapacity.

PIPES

8MPipe is a communication medium between two or more related or interrelated processes. It can be either within one process or a communication between the child and the parent processes. Communication can also be multi-level such as communication between the parent, the child and the grand-child, etc. Communication is achieved by one process writing into the pipe and other reading from the pipe. To achieve the pipe system call, create two files, one to write into the file and another to read from the file.




```
#include<unistd.h>

int pipe(int pipedes[2]);
```

This system call would create a pipe for one-way communication i.e., it creates two descriptors,first one is connected to read from the pipe and other one is connected to write into the pipe.

Descriptor pipedes[0] is for reading and pipedes[1] is for writing. Whatever is written intopipedes[1] can be read from pipedes[0].

This call would return zero on success and -1 in case of failure. To know the cause of failure,check with errno variable or perror() function.

```
#include <sys/types.h> #include <sys/stat.h>

#include <fontl.h>

int open(const char *pathname, int flags);

 int open(const char *pathname, int flags, mode_t mode);
```

Even though the basic operations for file are read and write, it is essential to open the file before performing the operations and closing the file after completion of the required operations. Usually, by default, 3 descriptors opened for every process, which are used for input (standard input - stdin), output (standard output - stdout) and error (standard error stderr) having file descriptors 0, 1 and 2 respectively.

Uni directional pipe:

Algorithm

- **Step 1** - Create a pipe using pipe() system call.
- **Step 2** – Send a message to the one end of the pipe.
- **Step 3** – Retrieve the message from the other end of the pipe and write it to the standard output.

Expected Output:

hello, world #1

hello, world #2

hello, *w*orld #3

Implementing command line pipe using exec() family of function:

Follow the steps to transfer the output of a process to pipe:

(i) Close the standard output descriptor
(ii) Use the following system calls, to take duplicate of output file descriptor of thepipe int dup(int fd); int dup2(int oldfd, int newfd);
(iii) Close the input file descriptor of the pipe
(iv) Now execute the process.

Follow the steps to get the input from the pipe for a process:

(i) Close the standard input descriptor
(ii) Take the duplicate of input file descriptor of the pipe using dup() system call
(iii) Close the input file descriptor of the pipe
(iv) Now execute the process

Named pipe

Named pipe (also known as FIFO) is one of the inter process communication tool. The system forFIFO is as follows

int mkfifo(const char *pathname, mode_t mode);

mkfifo() makes a FIFO special file with name pathname. Here mode specifies the FIFO's permissions. The permission can be like : O_CREAT|0644 Open FIFO in read-mode (O_RDONLY) to read and write-mode (O_WRONLY) to write.

Write and read two messages

using pipe.Algorithm

Step 1 - Create a pipe.

Step 2 – Send a message to the pipe.

Step 3 – Retrieve the message from the pipe and write it to the standard output.

Step 4 - Send another message to the pipe.

Step 5 - Retrieve the message from the pipe and write it to the standard output.

Note – Retrieving messages can also be done after sending all messages.

Expected Output:

Writing to pipe - Message 1 is Hi Reading from pipe - Message 1 is Hi Writing to pipe - Message 2 is Hello Reading from pipe - Message 2 is Hello

2. Program to write and read two messages through the pipe using the parent and the childprocesses.

Algorithm

Step 1 - Create a pipe.

Step 2 - Create a child process.

Step 3 – Parent process writes to the pipe.

Step 4 - Child process retrieves the message from the pipe and writes it to the standard output.

Step 5 – Repeat step 3 and step 4 once again.

Expected Output:

Parent Process - Writing to pipe - Message 1 is Hi
Parent Process - Writing to pipe - Message 2 is Hello
Child Process - Reading from pipe - Message 1 is Hi
Child Process - Reading from pipe – Message 2 is Hello

Two-way Communication Using Pipes

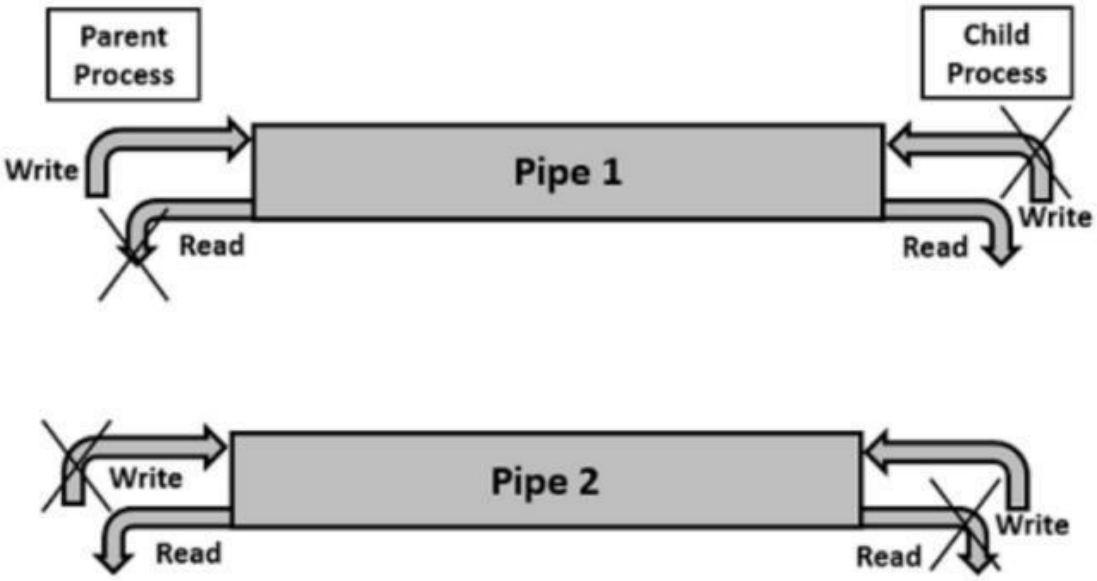
Following are the steps to achieve two-way communication -

Step 1 - Create two pipes. First one is for the parent to write and child to read, say as pipe l.Second one is for the child to write and parent to read, say as pipe2.

Step 2 - Create a child process.

Step 3 – Close unwanted ends as only one end is needed for each communication.

Step 4 - Close unwanted ends in the parent process, read end of pipel and write end of pipe2. **Step 5** – Close the unwanted ends in the child process, write end of pipel and read end of pipe2.**Step 6** - Perform the communication as required.



Acgieving two – way communication using pipes:

Step 1 - Create pipel for the parent process to write and the child process to read.

Step 2 - Create pipe2 for the child process to write and the parent process to read.

Step 3 – Close the unwanted ends of the pipe from the parent and child side.

Step 4 - Parent process to write a message and child process to read and display on the screen. **Step 5** –Child process to write a message and parent process to read and display on the screen.

Expected Output:

In Parent: Writing to pipe 1 - Message is Hi
In Child: Reading from pipe 1 - Message is HiI
n Child: Writing to pipe 2 – Message is Hello
In Parent: Reading from pipe 2 – Message is Hello

Practice:
Q. Write the output of the following program

```
#include<stdio.h>
 #include<unistd.h>
#include <sys/wait.h>
int main(){
int p[2];
char buff[25];
if(fork()==0){
printf("Child : Writing to pipe n");
write(p[1],"Welcome”,8);
printf("Child Exiting\n");
}
else
{wait(NULL);
printf("Parent : Reading from pipe \n");
read(p[0],buff,8);
printf("Pipe content is : %s
\n",buff);
}
return 0;
```

Output:

Result:

Ex. No. 12(a) **INTER PROCESS COMMUNICATION – SHARED MEMORY**
Date:

Aim:

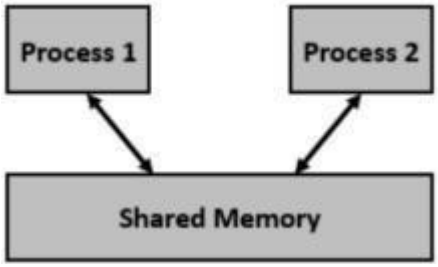
Inter Process Communication:

The popular IPC techniques are Shared Memory and Message Queues.

Shared memory:

We know that to communicate between two or more processes, we use shared memory but beforeusing the shared memory what needs to be done with the system calls,

- Create the shared memory segment or use an already created shared memory segment(shmget())
- Detach the process from the already attached shared memory segment (shmdt())
- Control operations on the shared memory segment (shmctl())



Inter Process Communication through shared memory is a concept where two or more process can access the common memory. And communication is done via this shared memory where changes made byone process can be viewed by another process.

The problem with pipes, fifo and message queue – is that for two process to exchangeinformation. The information has to go through the kernel.

• Server reads from the input file.
• The server writes this data in a message using either a pipe, fifo or message queue.
• The client reads the data from the IPC channel, again requiring the data to be copiedfrom kernel's IPC buffer to the client's buffer.
• Finally the data is copied from the client's buffer.

A total of four copies of data are required (2 read and 2 write). So, shared memory provides away by letting two or more processes share a memory segment. With Shared Memory the data is only copied twice – from input file into shared memory and from shared memory to the output file.

SYSTEM CALLS USED ARE:

- **ftok**(): is use to generate a unique key.

- **shmget**(): int shmget(key_t, size_tsize, intshmflg); upon successful completion, shmget() returnsan identifier for the shared memory segment.

- **shmat()**: Before you can use a shared memory segment, you have to attach yourself to it usingshmat(). void *shmat(int shmid , void *shmaddr , int shmflg);

- shmid is shared memory id. shmaddr specifies specific address to use but we should set it to zeroand OS will automatically choose the address.

- **shm**dt(): When you're done with the shared memory segment, your program should detach itselffrom it using shmdt(). int shmdt(void *shmaddr);

- **shmctl()**: when you detach from shared memory, it is not destroyed. So, to destroy shmctl() isused. shmctl(int shmid,IPC_RMID,NULL); The second argument, cmd, is the command to perform the required control operation on the shared memory segment.

Valid values for cmd are -

- **IPC_STAT** - Copies the information of the current values of each member of struct shmid_ds to the passed structure pointed by buf. This command requires read permission to the sharedmemorysegment.
- **IPC_SET** - Sets the user ID, group ID of the owner, permissions, etc. pointed to by structure buf.
- **IPC_RMID –** Marks the segment to be destroyed. The segment is destroyed only after the last process has detached it. **IPC_INFO** - Returns the information about the shared memory limits andparameters in the structure pointed by buf.
- **SHM_INF**O – Returns a shm_info structure containing information about the consumed system resources by the shared memory.

Program:1- Shared memory implementation using readers writers

problem.Writer process:

Algorithm:

Reader process:
Algorithm:

Writer program:

Reader Program:

Output:

Result:

Ex. No. 12(b) **INTER PROCESS COMMUNICATION – MESSAGE QUEUE**
Date:

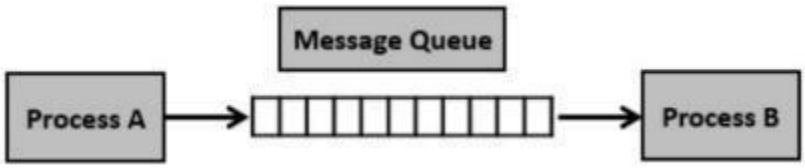
Aim:

Inter Process Communication-Message Queue

A message queue is a linked list of messages stored within the kernel and identified by a messagequeue identifier. A new queue is created or an existing queue opened **by msgget().**

New messages are added to the end of a queue by msgsnd(). Every message has a positive long integer type field, a non-negative length, and the actual data bytes *(*corresponding to the length), all of which are specified to msgsnd() when the message is added to a queue. Messages are fetched from a queueby **msgrcv().** We don't have to fetch the messages in a first-in, first-out order. Instead, we canfetch messages based on their type field.

All processes can exchange information through access to a common system message queue. Thesending process places a message (via some (OS) message-passing module) onto a queue which can be read by another process. Each message is given an identification or type so that processes can select the appropriate message. Process must share a common key in order to gain access to the queue in the first place.



System calls used for message queues:

- **ftok():** is use to generate a unique key.
- **msgget():** either returns the message queue identifier for a newly created message queue orreturns the identifiers for a queue which exists with the same key value.
- **msgsnd():** Data is placed on to a message queue by calling msgsnd().
- **msgrcv():** messages are retrieved from a queue.
- **msgctl():** It performs various operations on a queue. Generally it is use to destroy message queue.

Program :

To perform communication using message queues, following are the steps -

Writer Process:

Reader Process:

Writer program:

Output:

Reader program:

Output:

Result:

Ex. No. 13 **PROCESS SYNCHRONIZATION**

Date:

Aim:

Semaphore

Semaphore is used to implement process synchronization. This is to protect critical regionsshared among multiple processes.

Include the following header files for shared memory

```
<sys/ipc.h>, <sys/sem.h>, <sys/types.h>
```

System V Semaphore System Calls

To create a semaphore array,

```
int semget(key_t key, int nsems, int semflg)
```

key -> semaphore id
nsems -> no. of semaphores in the semaphore array
semflg -> `IPC_CREATE|0664` : to create a new semaphore
`IPC_EXCL|IPC_CREAT|0664` : to create new semaphore and the call fails if the semaphore already exists

To perform operations on the semaphore sets viz., allocating resources, waiting for the resourcesor freeing the resources,

```
int semop(int semid, struct sembuf *semops, size_t
nsemops)
```

semidsa-> semaphore id returned by semget() nsemops -> the number of operations in that array
semops -> The pointer to an array of operations to be performed on the semaphore set.
The structure is as follows

```
struct sembuf {
        unsigned short sem_num;  /* Semaphore set num */
                 short sem_op;   /* Semaphore operation */
        short sem_flg;  /*Operation flags, IPC_NOWAIT, SEM_UNDO */
};
```

Element, sem_op, in the above structure, indicates the operation that needs to be performed –

- If sem_op is –ve, allocate or obtain resources. Blocks the calling process until enoughresources have been freed by other processes, so that this process can allocate.
- If sem_op is zero, the calling process waits or sleeps until semaphore value reaches 0.
- If sem_op is +ve, release resources.

To perform control operation on semaphore,

```
int semctl(int semid, int semnum, int cmd,…);
```

semid -> identifier of the semaphore returned by semget()semnum -> semaphore number
cmd -> the command to perform on the semaphore. Ex. GETVAL, SETVALsemun -> value depends on the cmd. For few cases, this is not applicable.

Q1. Execute and write the output of the following program for *mutual exclusion*.

```
#include<sys/
ipc.h>
#include<sys/
sem.h>    int
main()
{
 int
 pid,semid,va
 l;struct
 sembuf sop;

 semid=semget((key_t)6,1,IPC_CREAT|0666);

 pid=fork();

 sop.sem_
 num=0;
 sop.sem_
 op=0;
 sop.sem_
 flg=0;

 if (pid!=0)
 {
   sleep(1);
   printf("The Parent waits for WAIT
   signal\n");semop(semid,&sop,1);
   printf("The Parent WAKED UP & doing her
   job\n");sleep(10);
   printf("Parent Over\n");
 }
 else
 {
   printf("The Child sets WAIT signal & doing her
   job\n");semctl(semid,0,SETVAL,1);
   sleep(10);
   printf("The Child sets WAKE signal & finished her
   job\n");semctl(semid,0,SETVAL,0);
   printf("Child Over\n");
 }
 return 0;
}
```

Output :

Q2. Write a program to perform process synchronization in producer-consumer problem

Output:

Result: