RAJALAKSHMI
ENGINEERING COLLEGE
An AUTONOMOUS Institution
Affiliated to ANNA UNIVERSITY, Chennai

DEPARTMENT OF ARTIFICIAL INTELLIGENCE AND MACHINE LEANNING LAB MANUAL

CS23431 – OPERATING SYSTEMS

(REGULATION 2023)

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Academic Year: 2024 - 2025

INDEX

Ex No: 1a
Date: 21/1/25

INSTALLATION AND CONFIGURATION OF LINUX

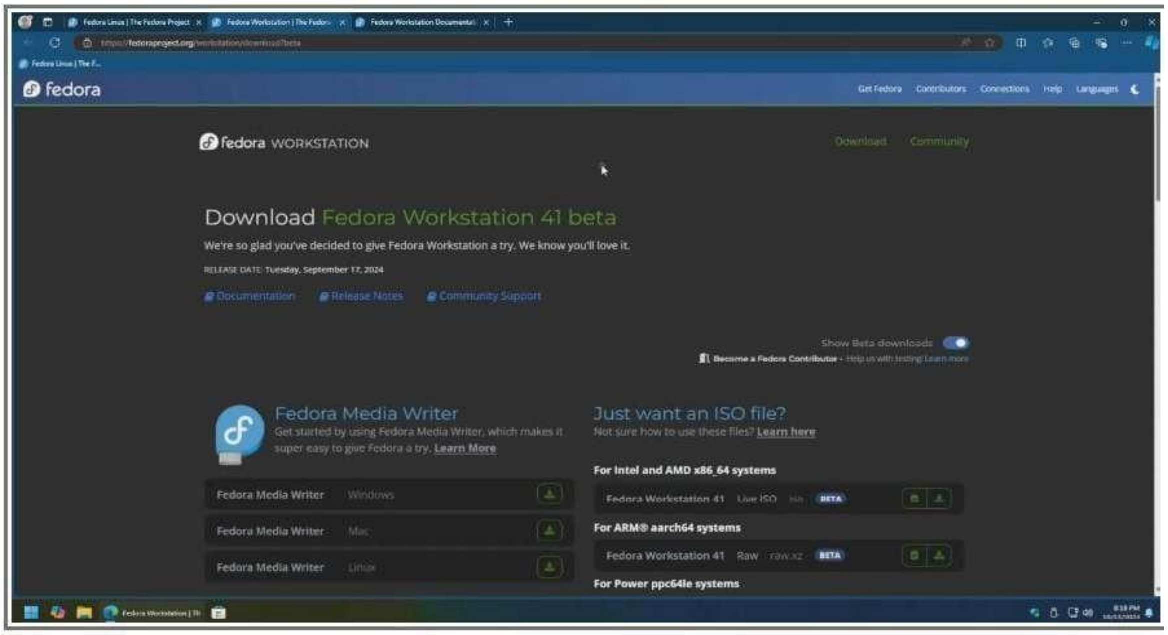
AIM:

To install and configure Linux operating system in a Virtual Machine.

INSTALLATION/CONFIGURATION STEPS:

1. Install the required packages for virtualization
dnf install xen virt-manager qemu libvirt
2. Configure xend to start up on boot
systemctl enable virt-manager. service
3. Reboot the machine
Reboot
4. Create a Virtual machine by first running virt-manager
virt-manager &
5. Click on File and then click to connect to localhost
6. In the base menu, right-click on the localhost (QEMU) to create a new VM 7. Select Linux ISO image
8. Choose puppy-linux.iso then the kernel version
9. Select CPU and RAM limits
10. Create default disk image to 8 GB
11. Click finish to create the new VM with PuppyLinux.

OUTPUT:



Fedora Linux | The Fedora Project
Fedora Workstation | The Fedora
Fedora Workstation Documentati
https://fedoraproject.org/workstation/download?beta
fedora
Get Fedora
Contributors
Connections
Help
Languages
fedora WORKSTATION
Download
Community

Download Fedora Workstation 41 beta

We're so glad you've decided to give Fedora Workstation a try. We know you'll love it.

RELEASE DATE: Tuesday, September 17, 2024

Become a Fedora Contributor - Help us with testing! Learn more

Fedora Media Writer

Get started by using Fedora Media Writer, which makes it super easy to give Fedora a try. Learn More

Just want an ISO file?

Not sure how to use these files? Learn here

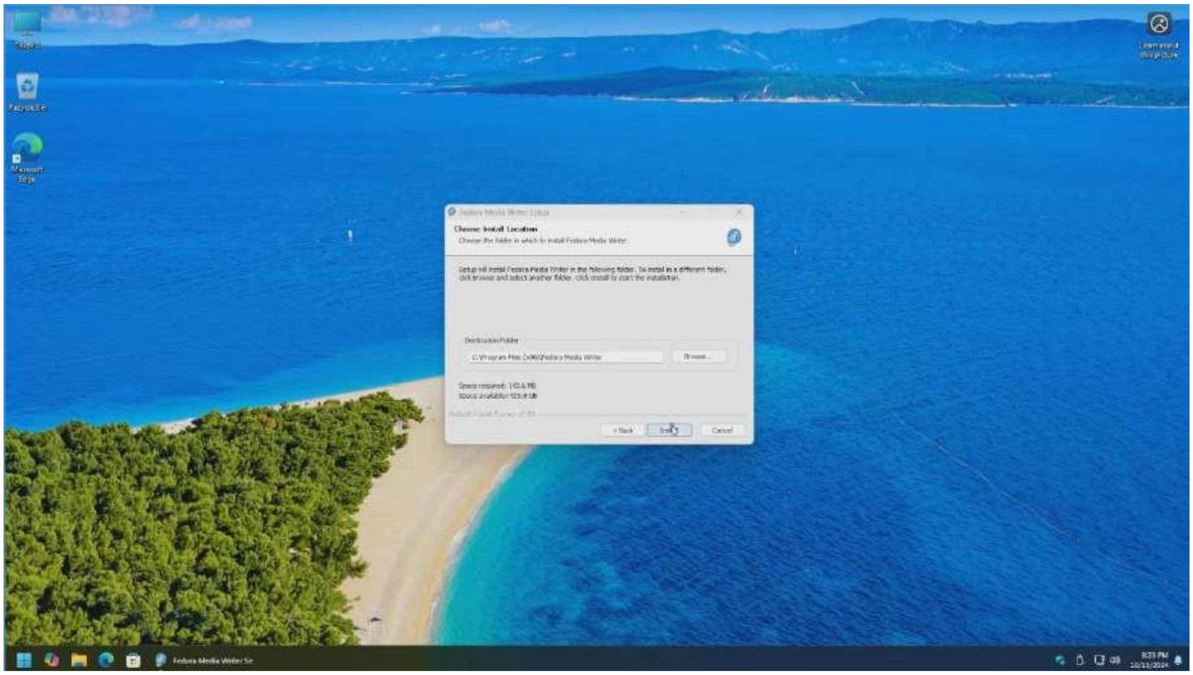
For Intel and AMD x86_64 systems

Fedora Workstation 41 Live ISO iso BETA

For ARM® aarch64 systems

Fedora Workstation 41 Raw raw.xz BETA

For Power ppc64le systems



Fedora Media Writer Setup

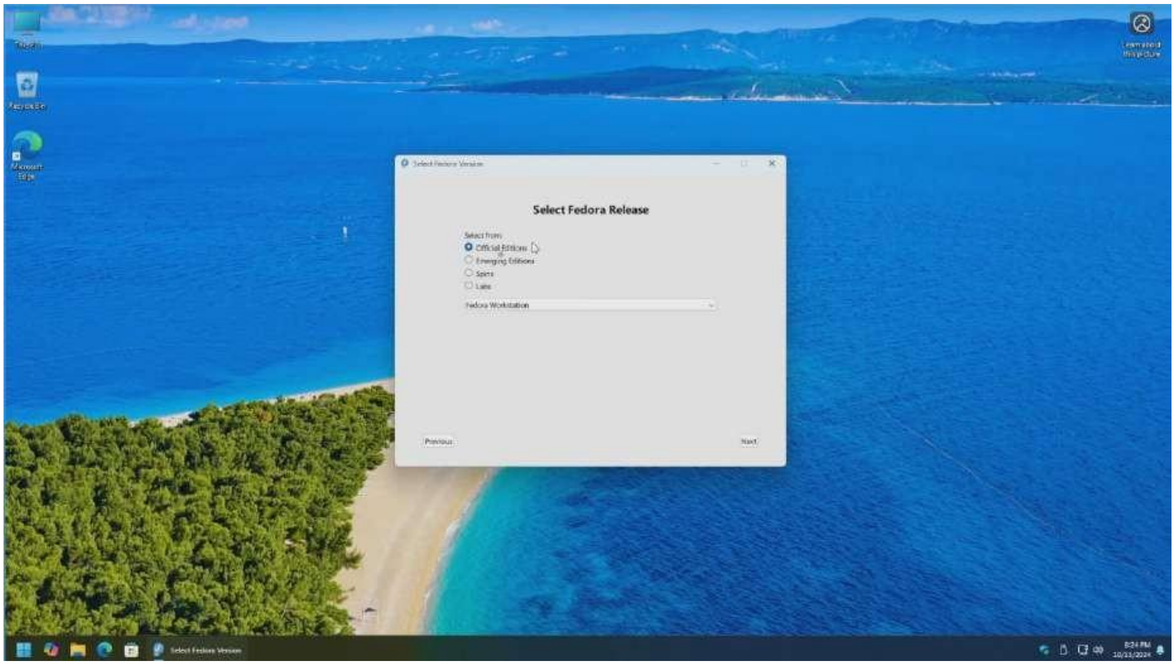
Choose Install Location

Choose the folder in which to install Fedora Media Writer.

Setup will install Fedora Media Writer in the following folder. To install in a different folder, click Browse and select another folder. Click Install to start the installation.

Destination Folder: C:\Program Files (x86)\Fedora Media Writer

Space required: 143.6 MB
Space available: 103.8 GB



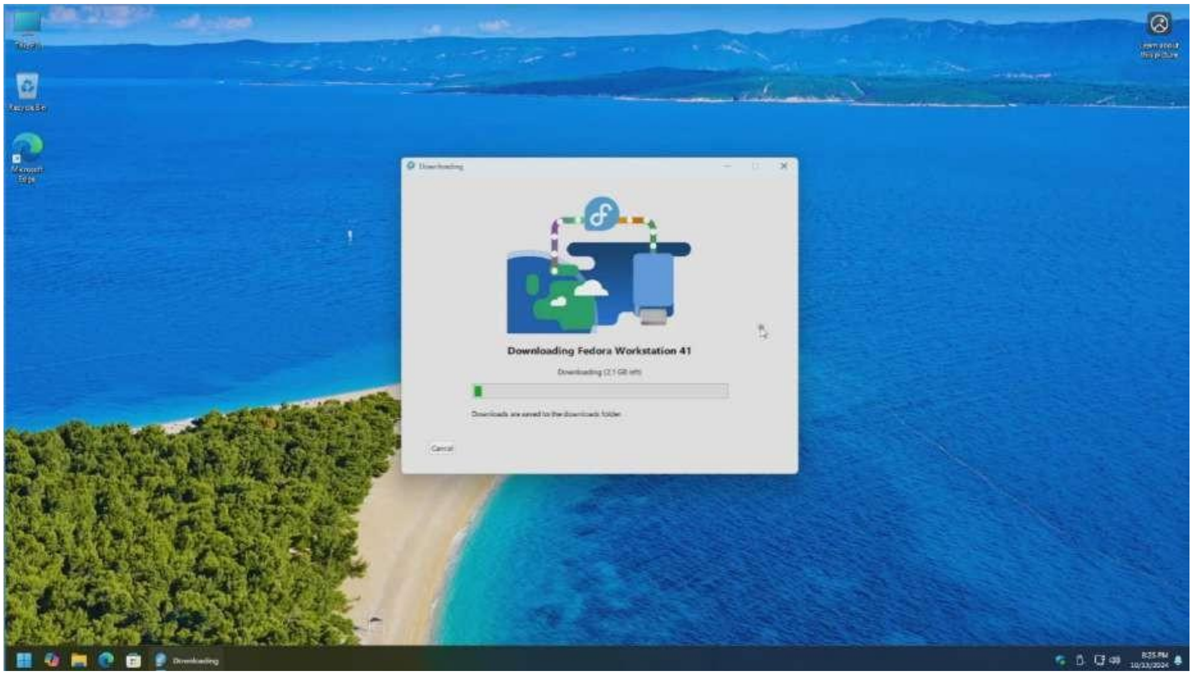
Select Fedora Version

Select Fedora Release

Select from:

- ● Official Editions
- ○ Emerging Editions
- ○ Spins
- ○ Labs

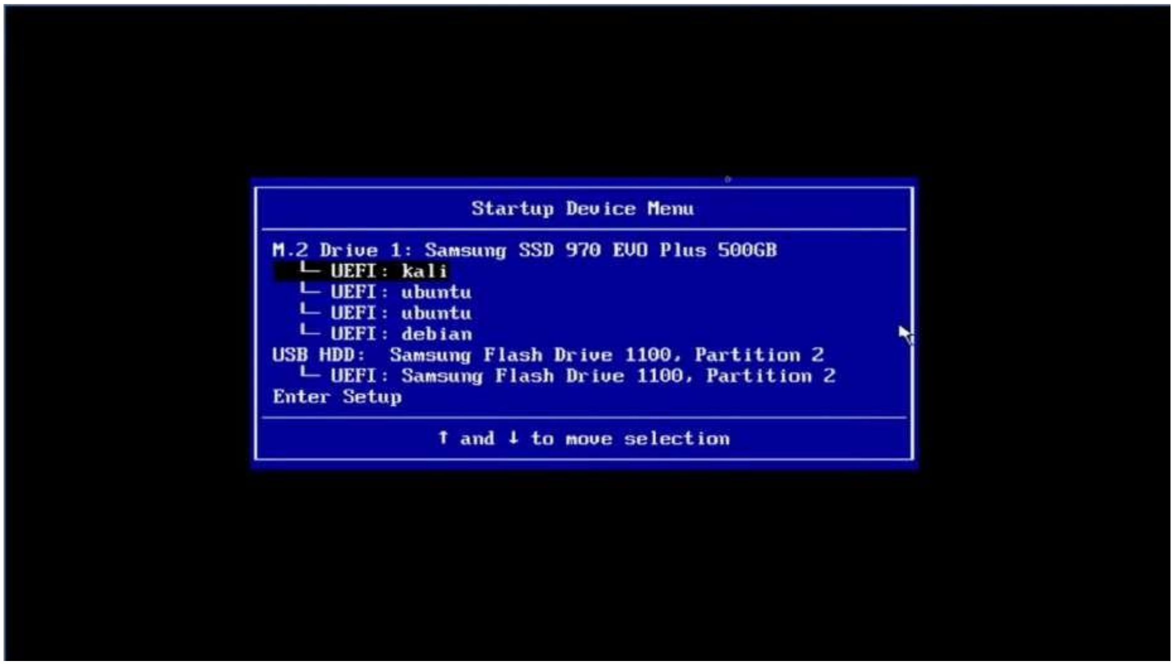
Fedora Workstation



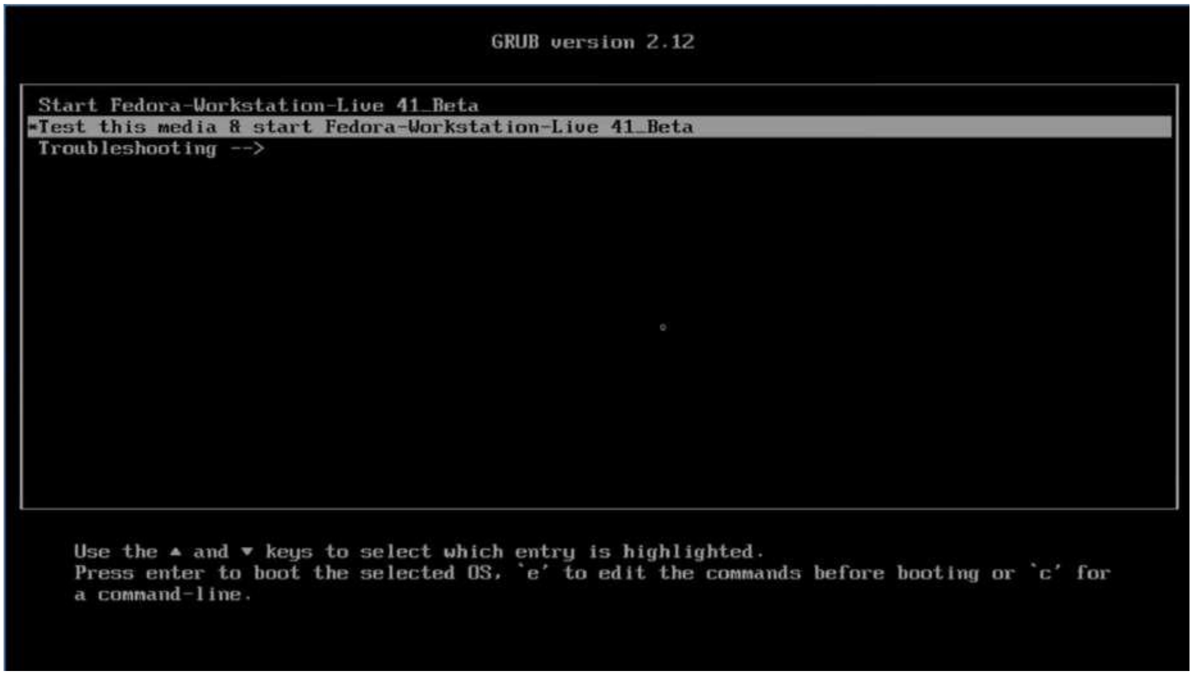
Downloading Fedora Workstation 41

Downloading (2.1 GB left)

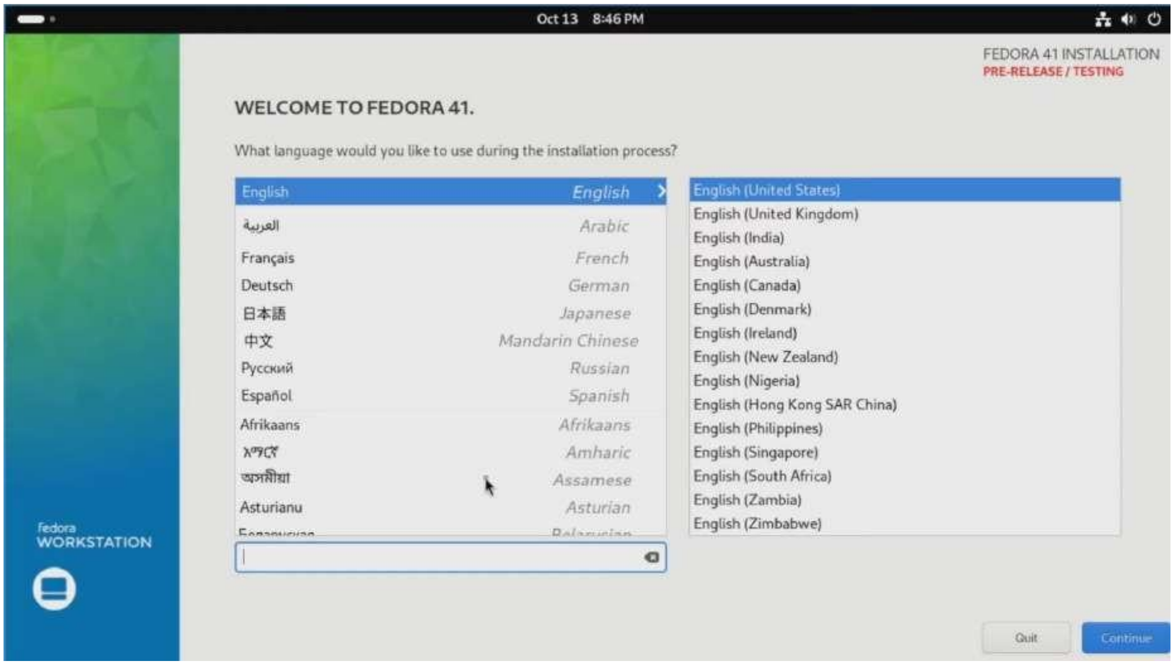
Downloads are saved to the downloads folder



```
                    Startup Device Menu
 M.2 Drive 1: Samsung SSD 970 EVO Plus 500GB
   └ UEFI: kali
   └ UEFI: ubuntu
   └ UEFI: ubuntu
   └ UEFI: debian
 USB HDD:  Samsung Flash Drive 1100, Partition 2
   └ UEFI: Samsung Flash Drive 1100, Partition 2
 Enter Setup
               ↑ and ↓ to move selection
```



```
GRUB version 2.12

 Start Fedora-Workstation-Live 41_Beta
*Test this media & start Fedora-Workstation-Live 41_Beta
 Troubleshooting -->

     Use the ▲ and ▼ keys to select which entry is highlighted.
     Press enter to boot the selected OS, `e' to edit the commands before booting or `c' for
     a command-line.
```

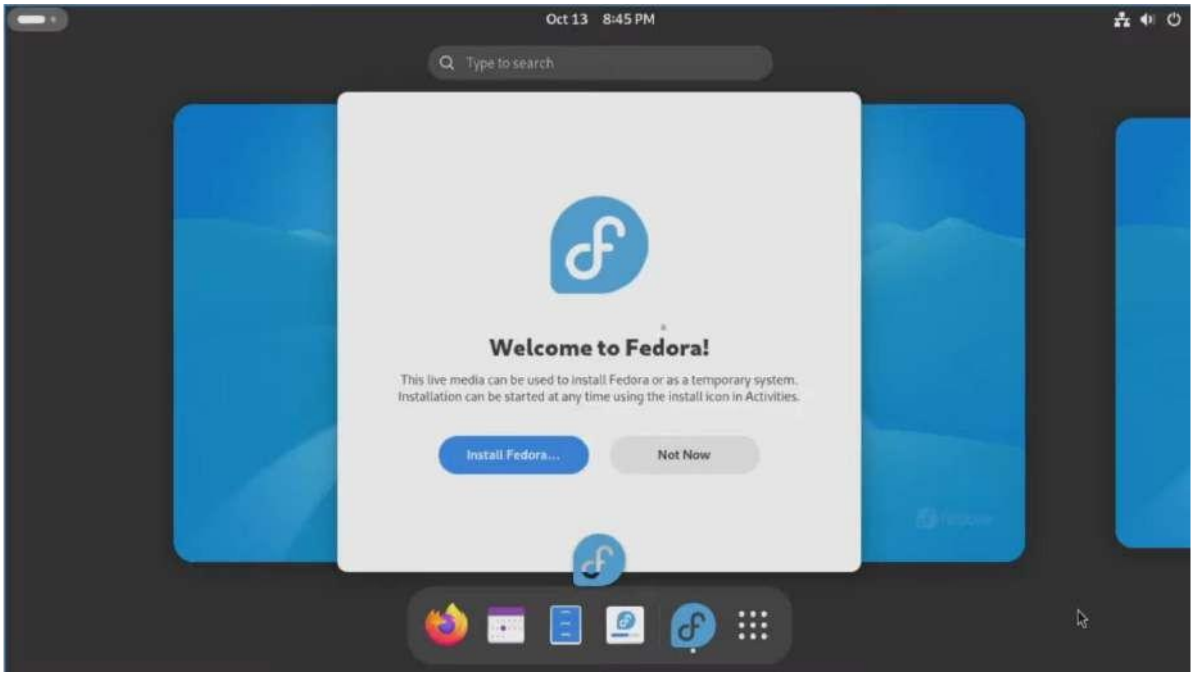


WELCOME TO FEDORA 41.

What language would you like to use during the installation process?

English	English
العربية	Arabic
Français	French
Deutsch	German
日本語	Japanese
中文	Mandarin Chinese
Русский	Russian
Español	Spanish
Afrikaans	Afrikaans
አማርኛ	Amharic
অসমীয়া	Assamese
Asturianu	Asturian
Беларуская	Belarusian

English (United States)
English (United Kingdom)
English (India)
English (Australia)
English (Canada)
English (Denmark)
English (Ireland)
English (New Zealand)
English (Nigeria)
English (Hong Kong SAR China)
English (Philippines)
English (Singapore)
English (South Africa)
English (Zambia)
English (Zimbabwe)



Welcome to Fedora!

This live media can be used to install Fedora or as a temporary system. Installation can be started at any time using the install icon in Activities.

RESULT:

Thus, the Linux OS is Installed and Configured.

Ex No: 1b
Date: 21/1/2025

BASIC LINUX COMMANDS

1.1 GENERAL PURPOSE COMMANDS

1. The ‘date’ command:

The date command displays the current date with day of week, month, day, time (24 hours clock) and the year.

SYNTAX: $ date

The date command can also be used with following format.

Format	Purpose	Example
+ %m	To display only month	$ date + %m
+ %h	To display month name	$ date + %h
+ %d	To display day of month	$ date + %d
+ %y	To display last two digits of the year	$ date + %y
+ %H	To display Hours	$ date + %H
+ %M	To display Minutes	$ date + %M
+ %S	To display Seconds	$ date + %S

2. The echo’command:

The echo command is used to print the message on the screen.

SYNTAX: $ echo

EXAMPLE: $ echo “God is Great”

3. The ‘cal’ command:

The cal command displays the specified month or year calendar.

SYNTAX: $ cal [month] [year]

EXAMPLE: $ cal Jan 2012

4. The ‘bc’ command:

Unix offers an online calculator and can be invoked by the command bc.
SYNTAX: $ bc
EXAMPLE: bc –l
16/4
5/2

5. The ‘who’ command
The who command is used to display the data about all the users who are currently logged into the system.
SYNTAX: $ who

6. The ‘who am i’ command
The who am i command displays data about login details of the user.
SYNTAX: $ who am i

7. The ‘id’ command
The id command displays the numerical value corresponding to your login.
SYNTAX: $ id

8. The ‘tty’ command
The tty (teletype) command is used to know the terminal name that we are using.
SYNTAX: $ tty

9. The ‘clear’ command
The clear command is used to clear the screen of your terminal.
SYNTAX: $ clear

10. The ‘man’ command
The man command gives you complete access to the Unix commands.
SYNTAX: $ man [command]

11. The ‘ps’ command
The ps command is used to the process currently alive in the machine with the 'ps' (process status) command, which displays information about process that are alive when you run the command. 'ps;' produces a snapshot of machine activity.
SYNTAX: $ ps
EXAMPLE: $ ps
$ ps –e
$ps -aux

12. The ‘uname’ command
The uname command is used to display relevant details about the operating system on the standard output.
-m -> Displays the machine id (i.e., name of the system hardware)
-n -> Displays the name of the network node. (host name)
-r -> Displays the release number of the operating system.
-s -> Displays the name of the operating system (i.e.. system name)

-v -> Displays the version of the operating system.
-a -> Displays the details of all the above five options.
SYNTAX: $ uname [option]
EXAMPLE: $ uname -a

1.2 DIRECTORY COMMANDS

1. The ‘pwd’ command:
The pwd (print working directory) command displays the current working directory. SYNTAX: $ pwd

2. The ‘mkdir’ command:
The mkdir is used to create an empty directory in a disk.
SYNTAX: $ mkdir dirname
EXAMPLE: $ mkdir receee

3. The ‘rmdir’ command:
The rmdir is used to remove a directory from the disk. Before removing a directory, the directory must be empty (no files and directories).
SYNTAX: $ rmdir dirname
EXAMPLE: $ rmdir receee

4. The ‘cd’ command:
The cd command is used to move from one directory to another.
SYNTAX: $ cd dirname
EXAMPLE: $ cd receee

5. The ‘ls’ command:
The ls command displays the list of files in the current working directory.
SYNTAX: $ ls
EXAMPLE: $ ls
$ ls –l
$ ls –a

1.3 FILE HANDLING COMMANDS

1. The ‘cat’ command:
The cat command is used to create a file.
SYNTAX: $ cat > filename
EXAMPLE: $ cat > rec

2. The ‘Display contents of a file’ command:
The cat command is also used to view the contents of a specified file.
SYNTAX: $ cat filename

3. The ‘cp’ command:

The cp command is used to copy the contents of one file to another and copies the file from one place to another.

SYNTAX: $ cp oldfile newfile

EXAMPLE: $ cp cse ece

4. The ‘rm’ command:

The rm command is used to remove or erase an existing file

SYNTAX: $ rm filename

EXAMPLE: $ rm rec

$ rm –f rec

Use option –fr to delete recursively the contents of the directory and its subdirectories.

5. The ‘mv’ command:

The mv command is used to move a file from one place to another. It removes a specified file from its original location and places it in specified location.

SYNTAX: $ mv oldfile newfile

EXAMPLE: $ mv cse eee

6. The ‘file’ command:

The file command is used to determine the type of file.

SYNTAX: $ file filename

EXAMPLE: $ file receee

7. The ‘wc’ command:

The wc command is used to count the number of words, lines and characters in a file. SYNTAX: $ wc filename

EXAMPLE: $ wc receee

8. The ‘Directing output to a file’ command:

The ls command lists the files on the terminal (screen). Using the redirection operator ‘>’ we can send the output to file instead of showing it on the screen.

SYNTAX: $ ls > filename

EXAMPLE: $ ls > cseeee

9. The ‘pipes’ command:

The Unix allows us to connect two commands together using these pipes. A pipe (|) is an mechanism by which the output of one command can be channeled into the input of another command. SYNTAX: $ command1 | command2

EXAMPLE: $ who | wc -l

10. The ‘tee’ command:

While using pipes, we have not seen any output from a command that gets piped into another command. To save the output, which is produced in the middle of a pipe, the tee command is very useful. SYNTAX: $ command | tee filename

EXAMPLE: $ who | tee sample | wc -l

11. The ‘Metacharacters of unix’ command:

Metacharacters are special characters that are at higher and abstract level compared to most of other characters in Unix. The shell understands and interprets these metacharacters in a special way. * - Specifies number of characters

?- Specifies a single character

[ ]- used to match a whole set of file names at a command line.

! – Used to Specify Not

EXAMPLE:

$ ls r** - Displays all the files whose name begins with ‘r’

$ ls ?kkk - Displays the files which are having ‘kkk’, from the second characters irrespective of the first character.

$ ls [a-m] – Lists the files whose names begins alphabets from ‘a’ to ‘m’

$ ls [!a-m] – Lists all files other than files whose names begins alphabets from ‘a’ to ‘m’

12. The ‘File permissions’ command:

File permission is the way of controlling the accessibility of file for each of three users namely Users, Groups and Others.

There are three types of file permissions are available, they are

r-read

w-write

x-execute

The permissions for each file can be divided into three parts of three bits each.

First three bits	Owner of the file
Next three bits	Group to which the owner of the file belongs
Last three bits	Others

EXAMPLE: $ ls college

-rwxr-xr-- 1 Lak std 1525 jan10 12:10 college

Where,

-rwx The file is readable, writable and executable by the owner of the file.

Lak Specifies Owner of the file.

r-x Indicates the absence of the write permission by the Group owner of the file. Std Is the Group Owner of the file.

r-- Indicates read permissions for others.

13. The ‘chmod’ command:

The chmod command is used to set the read, write and execute permissions for all categories of users for file.
SYNTAX: $ chmod category operation permission file

Category	Operation	permission
u-users	+ assign	r-read
g-group	-Remove	w-write
o-others	= assign absolutely	x-execute
a-all		

EXAMPLE:
$ chmod u –wx college
Removes write & execute permission for users for ‘college’ file.
$ chmod u +rw, g+rw college
Assigns read & write permission for users and groups for ‘college’ file.
$ chmod g=wx college
Assigns absolute permission for groups of all read, write and execute permissions for ‘college’ file.

14. The ‘Octal Notations’ command:
The file permissions can be changed using octal notations also. The octal notations for file permission are

Read permission	4
Write permission	2

EXAMPLE:
$ chmod 761 college

Execute permission	1

Assigns all permission to the owner, read and write permissions to the group and only executable permission to the others for ‘college’ file.
1.4 GROUPING COMMANDS

1. The ‘semicolon’ command:
The semicolon(;) command is used to separate multiple commands at the command line. SYNTAX: $ command1;command2;command3… ....;commandn
EXAMPLE: $ who;date

2. The ‘&&’ operator:
The ‘&&’ operator signifies the logical AND operation in between two or more valid Unix commands.It means that only if the first command is successfully executed, then the next command will executed.
SYNTAX: $ command1 && command && command3…………….&&commandn EXAMPLE: $ who && date.

3. The ‘||’ operator:
The ‘||’ operator signifies the logical OR operation in between two or more valid Unix commands.It means, that only if the first command will happen to be un successfully,it will continue to execute next commands.
SYNTAX: $ command1 || command || command3… .... ||commandn
EXAMPLE: $ who || date

1.5 FILTERS

1. The head filter
It displays the first ten lines of a file.
SYNTAX: $ head filename
EXAMPLE: $ head college Display the top ten lines.
$ head -5 college Display the top five lines.

2. The tail filter
It displays ten lines of a file from the end of the file.
SYNTAX: $ tail filename
EXAMPLE: $ tail college Display the last ten lines.
$tail -5 college Display the last five lines.

3. The more filter:
The pg command shows the file page by page.
SYNTAX: $ ls –l | more

4. The ‘grep’ command:
This command is used to search for a particular pattern from a file or from the standard input and display those lines on the standard output. “Grep” stands for “global search for regular expression.”
SYNTAX: $ grep [pattern] [file_name]
EXAMPLE: $ cat> student
Arun cse
Ram ece
Kani cse
$ grep “cse” student
Arun cse
Kani cse

5. The ‘sort’ command:
The sort command is used to sort the contents of a file. The sort command reports only to the screen, the actual file remains unchanged.
SYNTAX: $ sort filename
EXAMPLE: $ sort college
OPTIONS:

Command	Purpose
Sort –r college	Sorts and displays the file contents in reverse order
Sort –c college	Check if the file is sorted
Sort –n college	Sorts numerically
Sort –m college	Sorts numerically in reverse order
Sort –u college	Remove duplicate records
Sort –l college	Skip the column with +1 (one) option.Sorts according to second column

6. The ‘nl’ command:
The nl filter adds lines numbers to a file and it displays the file and not provides access to edit but simply displays the contents on the screen.
SYNTAX: $ nl filename
EXAMPLE: $ nl college

7. The ‘cut’ command:
We can select specified fields from a line of text using cut command.
SYNTAX: $ cut -c filename
EXAMPLE: $ cut -c college
OPTION:
-c – Option cut on the specified character position from each line.

1.5 OTHER ESSENTIAL COMMANDS

1. free

Display amount of free and used physical and swapped memory system. synopsis- free [options]

<u>example</u>

```
[root@localhost ~]# free -t
total used free shared buff/cache available Mem: 4044380 605464 2045080  148820 1393836 3226708 Swap:
2621436 0 2621436
Total: 6665816 605464 4666516
```

2. top

It provides a dynamic real-time view of processes in the system.

synopsis- top [options]

<u>example</u>

```
[root@localhost ~]# top
top - 08:07:28 up 24 min, 2 users, load average: 0.01, 0.06, 0.23
Tasks: 211 total, 1 running, 210 sleeping, 0 stopped, 0 zombie
%Cpu(s): 0.8 us, 0.3 sy, 0.0 ni, 98.9 id, 0.0 wa, 0.0 hi, 0.0 si, 0.0 st
KiB Mem : 4044380 total, 2052960 free, 600452 used, 1390968 buff/cache KiB Swap:  2621436 total,
2621436 free, 0 used. 3234820 avail Mem PID USER PR NI VIRT RES  SHR S %CPU %MEM TIME+
COMMAND
1105 root 20 0 175008 75700 51264 S 1.7 1.9 0:20.46 Xorg 2529 root 20 0 80444  32640 24796 S 1.0 0.8
0:02.47 gnome-term
```

3. ps

It reports the snapshot of current processes

synopsis- ps [options]

<u>example</u>

```
[root@localhost ~]# ps -e
PID TTY TIME CMD
1 ? 00:00:03 systemd
2 ? 00:00:00 kthreadd
3 ? 00:00:00 ksoftirqd/0
```

4. vmstat

It reports virtual memory statistics

synopsis- vmstat [options]

<u>example</u>

```
[root@localhost ~]# vmstat
procs -----------memory---------- ---swap-- -----io---- -system-- ------cpu ------ r b swpd free buff cache si so bi bo
in cs us sy id wa st 0 0 0 1879368  1604 1487116 0 0 64 7 72 140 1 0 97 1 0
```

5. df

It displays the amount of disk space available in file-system.

Synopsis- df [options]

<u>example</u>

```
[root@localhost ~]# df
Filesystem 1K-blocks Used Available Use% Mounted on
devtmpfs 2010800 0 2010800 0% /dev tmpfs 2022188 148 2022040 1% /dev/shm  tmpfs 2022188 1404
2020784 1% /run /dev/sda6 487652 168276 289680 37% /boot
```

6. ping

It is used verify that a device can communicate with another on network. PING stands for Packet Internet Groper.

synopsis- ping [options]

```
[root@localhost ~]# ping 172.16.4.1
PING 172.16.4.1 (172.16.4.1) 56(84) bytes of data.
64 bytes from 172.16.4.1: icmp_seq=1 ttl=64 time=0.328 ms
64 bytes from 172.16.4.1: icmp_seq=2 ttl=64 time=0.228 ms
64 bytes from 172.16.4.1: icmp_seq=3 ttl=64 time=0.264 ms  64 bytes from 172.16.4.1: icmp_seq=4 ttl=64
time=0.312 ms
--- 172.16.4.1 ping statistics ---
4 packets transmitted, 4 received, 0% packet loss, time 3000ms  rtt min/avg/max/mdev =
0.228/0.283/0.328/0.039 ms
```

7. ifconfig

It is used configure network interface.

synopsis- ifconfig [options]

<u>example</u>

```
root@localhost ~]# ifconfig
enp2s0: flags=4163<UP,BROADCAST,RUNNING,MULTICAST> mtu  1500 inet 172.16.6.102 netmask
255.255.252.0 broadcast 172.16.7.255 inet6  fe80::4a0f:cfff:fe6d:6057 prefixlen 64  scopeid 0x20<link>
ether 48:0f:cf:6d:60:57 txqueuelen 1000 (Ethernet)
RX packets 23216 bytes 2483338 (2.3 MiB)
RX errors 0 dropped 5 overruns 0 frame 0
TX packets 1077 bytes 107740 (105.2 KiB)
TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0 8.
```

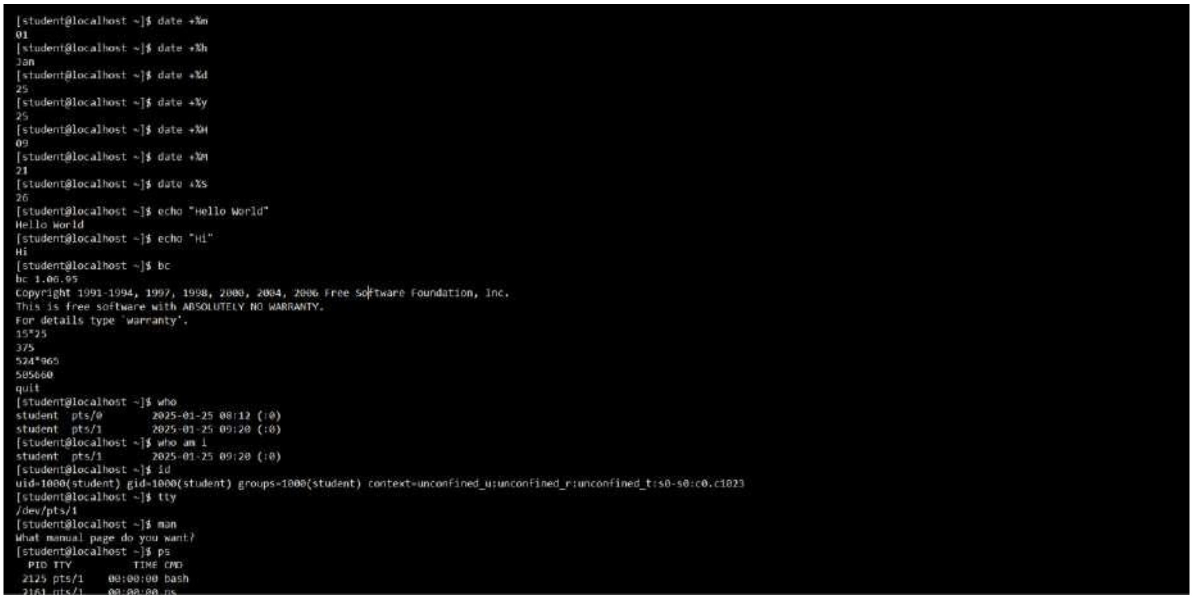
traceroute

It tracks the route the packet takes to reach the destination. synopsis- traceroute [options]

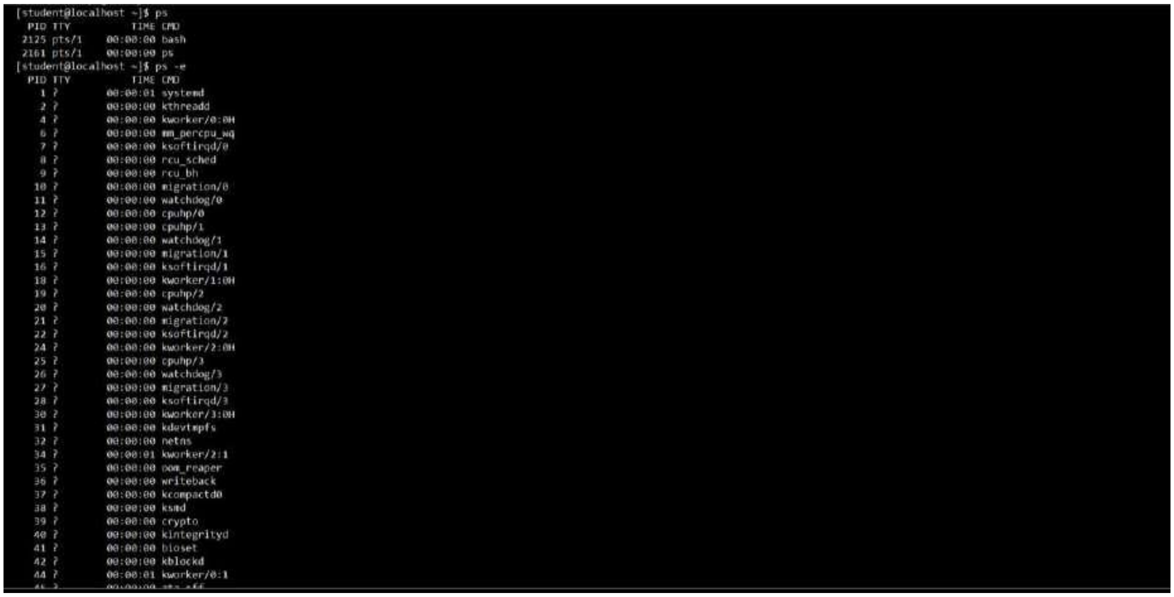
<u>example</u>

```
[root@localhost ~]# traceroute www.rajalakshmi.org
traceroute to www.rajalakshmi.org (220.227.30.51), 30 hops max, 60     byte  packets 1 gateway (172.16.4.1)
0.299 ms 0.297 ms 0.327 ms  2
220.225.219.38 (220.225.219.38) 6.185 ms 6.203 ms 6.189 ms
```

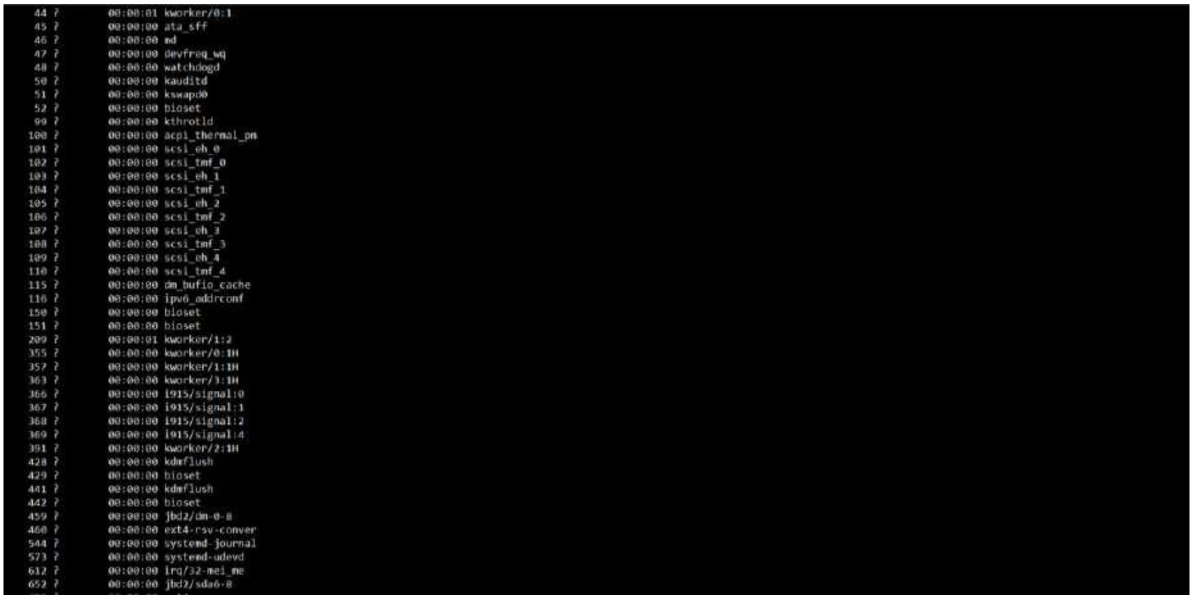
OUTPUT:



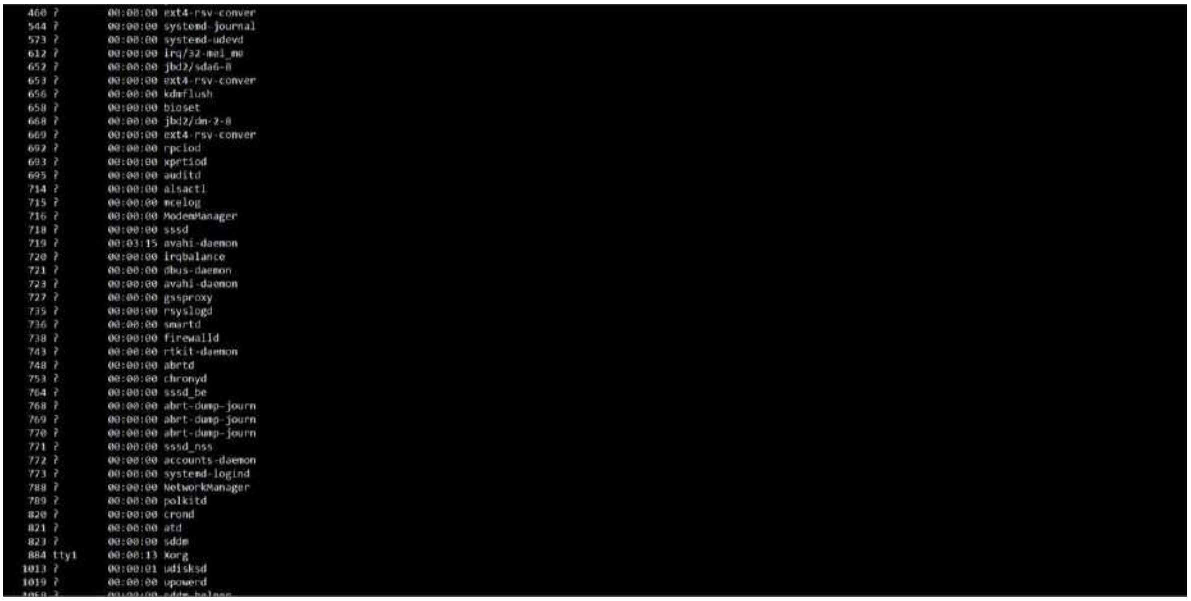
```
[student@localhost ~]$ date +%m
01
[student@localhost ~]$ date +%h
Jan
[student@localhost ~]$ date +%d
25
[student@localhost ~]$ date +%y
25
[student@localhost ~]$ date +%H
09
[student@localhost ~]$ date +%M
21
[student@localhost ~]$ date +%S
26
[student@localhost ~]$ echo "Hello World"
Hello World
[student@localhost ~]$ echo "Hi"
Hi
[student@localhost ~]$ bc
bc 1.06.95
Copyright 1991-1994, 1997, 1998, 2000, 2004, 2006 Free Software Foundation, Inc.
This is free software with ABSOLUTELY NO WARRANTY.
For details type `warranty'.
15*25
375
524*965
505660
quit
[student@localhost ~]$ who
student  pts/0        2025-01-25 08:12 (:0)
student  pts/1        2025-01-25 09:20 (:0)
[student@localhost ~]$ who am i
student  pts/1        2025-01-25 09:20 (:0)
[student@localhost ~]$ id
uid=1000(student) gid=1000(student) groups=1000(student) context=unconfined_u:unconfined_r:unconfined_t:s0-s0:c0.c1023
[student@localhost ~]$ tty
/dev/pts/1
[student@localhost ~]$ man
What manual page do you want?
[student@localhost ~]$ ps
  PID TTY          TIME CMD
 2125 pts/1    00:00:00 bash
 2161 pts/1    00:00:00 ps
```



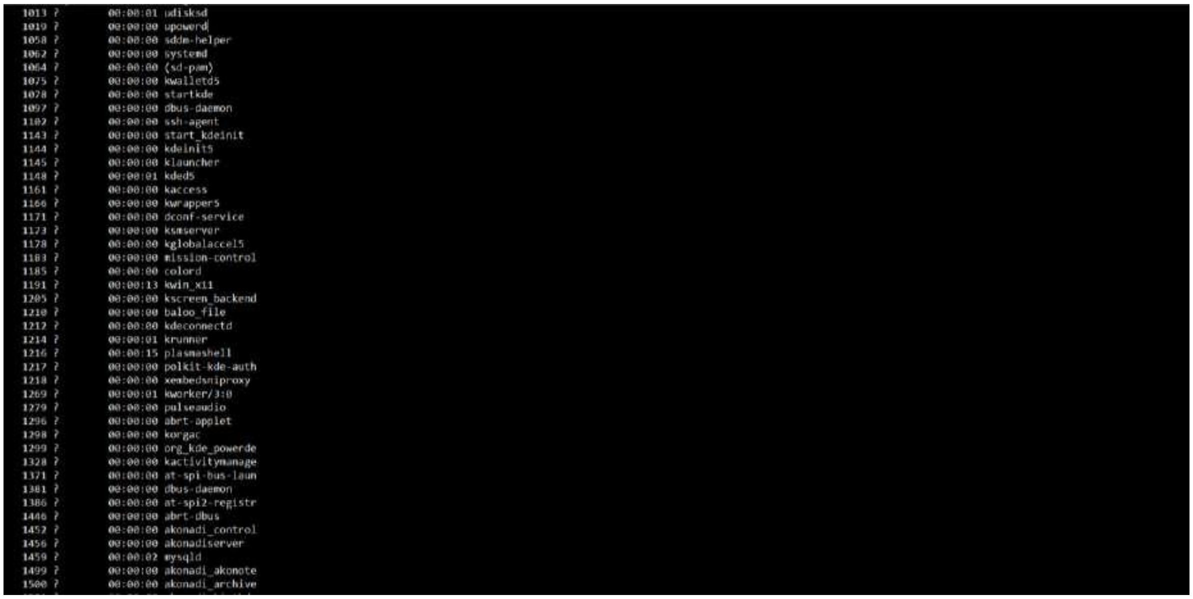
```
[student@localhost ~]$ ps
  PID TTY          TIME CMD
 2125 pts/1    00:00:00 bash
 2161 pts/1    00:00:00 ps
[student@localhost ~]$ ps -e
  PID TTY          TIME CMD
    1 ?        00:00:01 systemd
    2 ?        00:00:00 kthreadd
    4 ?        00:00:00 kworker/0:0H
    6 ?        00:00:00 mm_percpu_wq
    7 ?        00:00:00 ksoftirqd/0
    8 ?        00:00:00 rcu_sched
    9 ?        00:00:00 rcu_bh
   10 ?        00:00:00 migration/0
   11 ?        00:00:00 watchdog/0
   12 ?        00:00:00 cpuhp/0
   13 ?        00:00:00 cpuhp/1
   14 ?        00:00:00 watchdog/1
   15 ?        00:00:00 migration/1
   16 ?        00:00:00 ksoftirqd/1
   18 ?        00:00:00 kworker/1:0H
   19 ?        00:00:00 cpuhp/2
   20 ?        00:00:00 watchdog/2
   21 ?        00:00:00 migration/2
   22 ?        00:00:00 ksoftirqd/2
   24 ?        00:00:00 kworker/2:0H
   25 ?        00:00:00 cpuhp/3
   26 ?        00:00:00 watchdog/3
   27 ?        00:00:00 migration/3
   28 ?        00:00:00 ksoftirqd/3
   30 ?        00:00:00 kworker/3:0H
   31 ?        00:00:00 kdevtmpfs
   32 ?        00:00:00 netns
   34 ?        00:00:01 kworker/2:1
   35 ?        00:00:00 oom_reaper
   36 ?        00:00:00 writeback
   37 ?        00:00:00 kcompactd0
   38 ?        00:00:00 ksmd
   39 ?        00:00:00 crypto
   40 ?        00:00:00 kintegrityd
   41 ?        00:00:00 bioset
   42 ?        00:00:00 kblockd
   44 ?        00:00:01 kworker/0:1
```



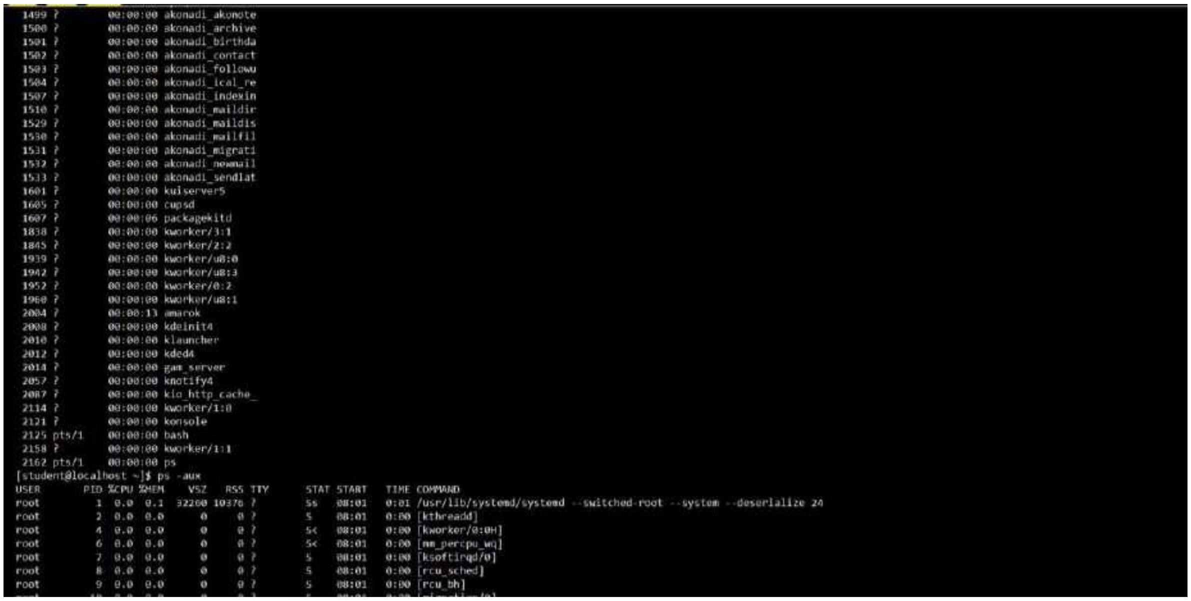
```
   44 ?        00:00:01 kworker/0:1
   45 ?        00:00:00 ata_sff
   46 ?        00:00:00 md
   47 ?        00:00:00 devfreq_wq
   48 ?        00:00:00 watchdogd
   50 ?        00:00:00 kauditd
   51 ?        00:00:00 kswapd0
   52 ?        00:00:00 bioset
   99 ?        00:00:00 kthrotld
  100 ?        00:00:00 acpi_thermal_pm
  101 ?        00:00:00 scsi_eh_0
  102 ?        00:00:00 scsi_tmf_0
  103 ?        00:00:00 scsi_eh_1
  104 ?        00:00:00 scsi_tmf_1
  105 ?        00:00:00 scsi_eh_2
  106 ?        00:00:00 scsi_tmf_2
  107 ?        00:00:00 scsi_eh_3
  108 ?        00:00:00 scsi_tmf_3
  109 ?        00:00:00 scsi_eh_4
  110 ?        00:00:00 scsi_tmf_4
  115 ?        00:00:00 dm_bufio_cache
  116 ?        00:00:00 ipv6_addrconf
  150 ?        00:00:00 bioset
  151 ?        00:00:00 bioset
  209 ?        00:00:01 kworker/1:2
  355 ?        00:00:00 kworker/0:1H
  357 ?        00:00:00 kworker/1:1H
  363 ?        00:00:00 kworker/3:1H
  366 ?        00:00:00 i915/signal:0
  367 ?        00:00:00 i915/signal:1
  368 ?        00:00:00 i915/signal:2
  369 ?        00:00:00 i915/signal:4
  391 ?        00:00:00 kworker/2:1H
  428 ?        00:00:00 kdmflush
  429 ?        00:00:00 bioset
  441 ?        00:00:00 kdmflush
  442 ?        00:00:00 bioset
  459 ?        00:00:00 jbd2/dm-0-8
  460 ?        00:00:00 ext4-rsv-conver
  544 ?        00:00:00 systemd-journal
  573 ?        00:00:00 systemd-udevd
  612 ?        00:00:00 irq/32-mei_me
  652 ?        00:00:00 jbd2/sda6-8
```



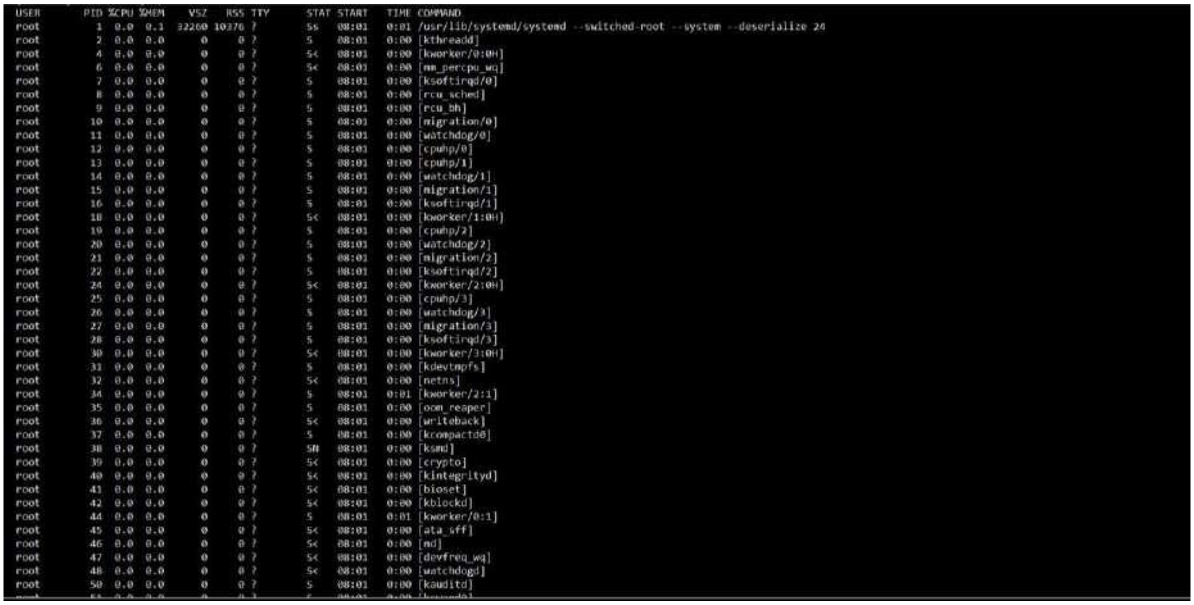
```
  460 ?        00:00:00 ext4-rsv-conver
  544 ?        00:00:00 systemd-journal
  573 ?        00:00:00 systemd-udevd
  612 ?        00:00:00 irq/32-mei_me
  652 ?        00:00:00 jbd2/sda6-8
  653 ?        00:00:00 ext4-rsv-conver
  656 ?        00:00:00 kdmflush
  658 ?        00:00:00 bioset
  668 ?        00:00:00 jbd2/dm-2-8
  669 ?        00:00:00 ext4-rsv-conver
  692 ?        00:00:00 rpciod
  693 ?        00:00:00 xprtiod
  695 ?        00:00:00 auditd
  714 ?        00:00:00 alsactl
  715 ?        00:00:00 mcelog
  716 ?        00:00:00 ModemManager
  718 ?        00:00:00 sssd
  719 ?        00:03:15 avahi-daemon
  720 ?        00:00:00 irqbalance
  721 ?        00:00:00 dbus-daemon
  723 ?        00:00:00 avahi-daemon
  727 ?        00:00:00 gssproxy
  735 ?        00:00:00 rsyslogd
  736 ?        00:00:00 smartd
  738 ?        00:00:00 firewalld
  743 ?        00:00:00 rtkit-daemon
  748 ?        00:00:00 abrtd
  753 ?        00:00:00 chronyd
  764 ?        00:00:00 sssd_be
  768 ?        00:00:00 abrt-dump-journ
  769 ?        00:00:00 abrt-dump-journ
  770 ?        00:00:00 abrt-dump-journ
  771 ?        00:00:00 sssd_nss
  772 ?        00:00:00 accounts-daemon
  773 ?        00:00:00 systemd-logind
  788 ?        00:00:00 NetworkManager
  789 ?        00:00:00 polkitd
  820 ?        00:00:00 crond
  821 ?        00:00:00 atd
  823 ?        00:00:00 sddm
  884 tty1     00:00:13 Xorg
 1013 ?        00:00:01 udisksd
 1019 ?        00:00:00 upowerd
```



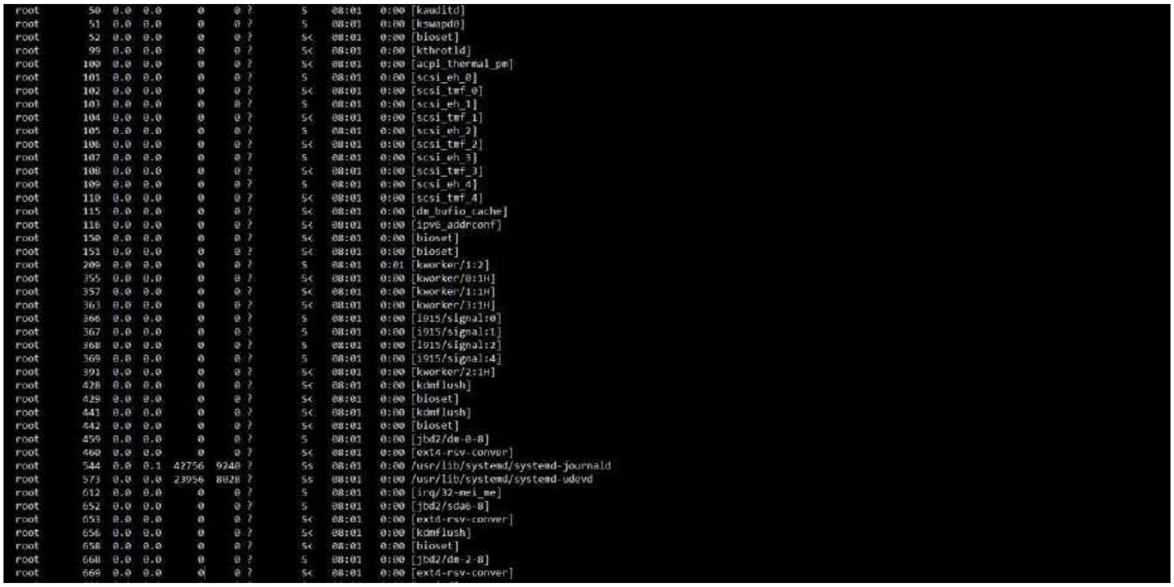
```
  1013 ?        00:00:01 udisksd
  1019 ?        00:00:00 upowerd
  1058 ?        00:00:00 sddm-helper
  1062 ?        00:00:00 systemd
  1064 ?        00:00:00 (sd-pam)
  1075 ?        00:00:00 kwalletd5
  1078 ?        00:00:00 startkde
  1097 ?        00:00:00 dbus-daemon
  1102 ?        00:00:00 ssh-agent
  1143 ?        00:00:00 start_kdeinit
  1144 ?        00:00:00 kdeinit5
  1145 ?        00:00:00 klauncher
  1148 ?        00:00:01 kded5
  1161 ?        00:00:00 kaccess
  1166 ?        00:00:00 kwrapper5
  1171 ?        00:00:00 dconf-service
  1173 ?        00:00:00 ksmserver
  1178 ?        00:00:00 kglobalaccel5
  1183 ?        00:00:00 mission-control
  1185 ?        00:00:00 colord
  1191 ?        00:00:13 kwin_x11
  1205 ?        00:00:00 kscreen_backend
  1210 ?        00:00:00 baloo_file
  1212 ?        00:00:00 kdeconnectd
  1214 ?        00:00:01 krunner
  1216 ?        00:00:15 plasmashell
  1217 ?        00:00:00 polkit-kde-auth
  1218 ?        00:00:00 xembedsniproxy
  1269 ?        00:00:01 kworker/3:0
  1279 ?        00:00:00 pulseaudio
  1296 ?        00:00:00 abrt-applet
  1298 ?        00:00:00 korgac
  1299 ?        00:00:00 org_kde_powerde
  1328 ?        00:00:00 kactivitymanage
  1371 ?        00:00:00 at-spi-bus-laun
  1381 ?        00:00:00 dbus-daemon
  1386 ?        00:00:00 at-spi2-registr
  1446 ?        00:00:00 abrt-dbus
  1452 ?        00:00:00 akonadi_control
  1456 ?        00:00:00 akonadiserver
  1459 ?        00:00:02 mysqld
  1499 ?        00:00:00 akonadi_akonote
  1500 ?        00:00:00 akonadi_archive
```



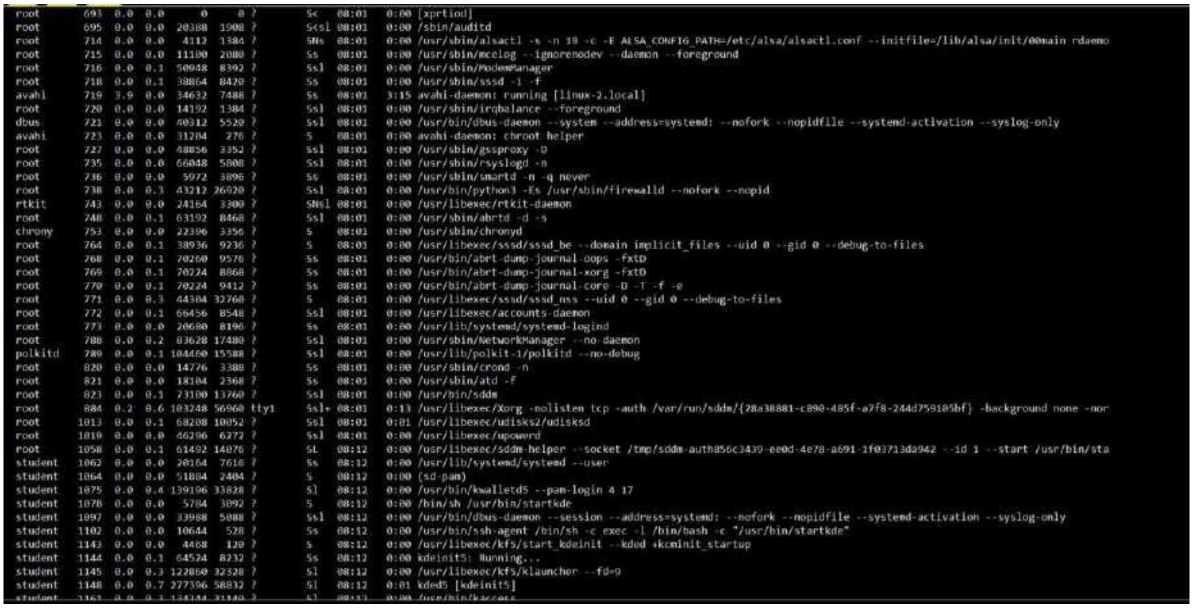
```
  1499 ?        00:00:00 akonadi_akonote
  1500 ?        00:00:00 akonadi_archive
  1501 ?        00:00:00 akonadi_birthda
  1502 ?        00:00:00 akonadi_contact
  1503 ?        00:00:00 akonadi_followu
  1504 ?        00:00:00 akonadi_ical_re
  1507 ?        00:00:00 akonadi_indexin
  1510 ?        00:00:00 akonadi_maildir
  1529 ?        00:00:00 akonadi_maildis
  1530 ?        00:00:00 akonadi_mailfil
  1531 ?        00:00:00 akonadi_migrati
  1532 ?        00:00:00 akonadi_newmail
  1533 ?        00:00:00 akonadi_sendlat
  1601 ?        00:00:00 kuiserver5
  1605 ?        00:00:00 cupsd
  1607 ?        00:00:06 packagekitd
  1838 ?        00:00:00 kworker/3:1
  1845 ?        00:00:00 kworker/2:2
  1939 ?        00:00:00 kworker/u8:0
  1942 ?        00:00:00 kworker/u8:3
  1952 ?        00:00:00 kworker/0:2
  1960 ?        00:00:00 kworker/u8:1
  2004 ?        00:00:13 amarok
  2008 ?        00:00:00 kdeinit4
  2010 ?        00:00:00 klauncher
  2012 ?        00:00:00 kded4
  2014 ?        00:00:00 gam_server
  2057 ?        00:00:00 knotify4
  2087 ?        00:00:00 kio_http_cache_
  2114 ?        00:00:00 kworker/1:0
  2121 ?        00:00:00 konsole
  2125 pts/1    00:00:00 bash
  2158 ?        00:00:00 kworker/1:1
  2162 pts/1    00:00:00 ps
[student@localhost ~]$ ps -aux
USER       PID %CPU %MEM    VSZ   RSS TTY      STAT START   TIME COMMAND
root         1  0.0  0.1  32260 10376 ?        Ss   08:01   0:01 /usr/lib/systemd/systemd --switched-root --system --deserialize 24
root         2  0.0  0.0      0     0 ?        S    08:01   0:00 [kthreadd]
root         4  0.0  0.0      0     0 ?        S<   08:01   0:00 [kworker/0:0H]
root         6  0.0  0.0      0     0 ?        S<   08:01   0:00 [mm_percpu_wq]
root         7  0.0  0.0      0     0 ?        S    08:01   0:00 [ksoftirqd/0]
root         8  0.0  0.0      0     0 ?        S    08:01   0:00 [rcu_sched]
root         9  0.0  0.0      0     0 ?        S    08:01   0:00 [rcu_bh]
```



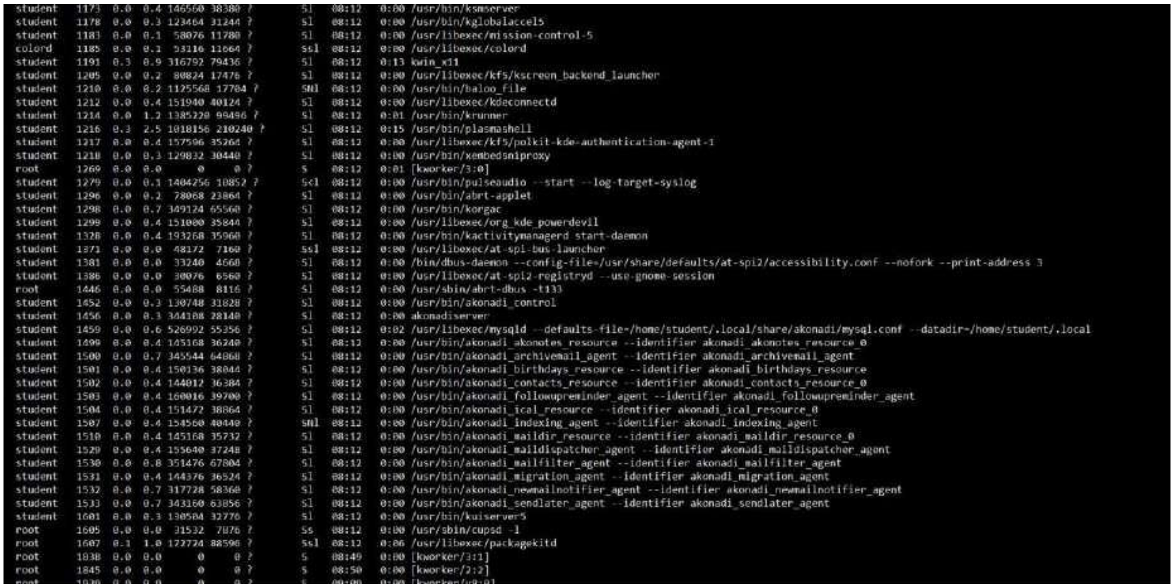
```
USER       PID %CPU %MEM    VSZ   RSS TTY      STAT START   TIME COMMAND
root         1  0.0  0.1  32260 10376 ?        Ss   08:01   0:01 /usr/lib/systemd/systemd --switched-root --system --deserialize 24
root         2  0.0  0.0      0     0 ?        S    08:01   0:00 [kthreadd]
root         4  0.0  0.0      0     0 ?        S<   08:01   0:00 [kworker/0:0H]
root         6  0.0  0.0      0     0 ?        S<   08:01   0:00 [mm_percpu_wq]
root         7  0.0  0.0      0     0 ?        S    08:01   0:00 [ksoftirqd/0]
root         8  0.0  0.0      0     0 ?        S    08:01   0:00 [rcu_sched]
root         9  0.0  0.0      0     0 ?        S    08:01   0:00 [rcu_bh]
root        10  0.0  0.0      0     0 ?        S    08:01   0:00 [migration/0]
root        11  0.0  0.0      0     0 ?        S    08:01   0:00 [watchdog/0]
root        12  0.0  0.0      0     0 ?        S    08:01   0:00 [cpuhp/0]
root        13  0.0  0.0      0     0 ?        S    08:01   0:00 [cpuhp/1]
root        14  0.0  0.0      0     0 ?        S    08:01   0:00 [watchdog/1]
root        15  0.0  0.0      0     0 ?        S    08:01   0:00 [migration/1]
root        16  0.0  0.0      0     0 ?        S    08:01   0:00 [ksoftirqd/1]
root        18  0.0  0.0      0     0 ?        S<   08:01   0:00 [kworker/1:0H]
root        19  0.0  0.0      0     0 ?        S    08:01   0:00 [cpuhp/2]
root        20  0.0  0.0      0     0 ?        S    08:01   0:00 [watchdog/2]
root        21  0.0  0.0      0     0 ?        S    08:01   0:00 [migration/2]
root        22  0.0  0.0      0     0 ?        S    08:01   0:00 [ksoftirqd/2]
root        24  0.0  0.0      0     0 ?        S<   08:01   0:00 [kworker/2:0H]
root        25  0.0  0.0      0     0 ?        S    08:01   0:00 [cpuhp/3]
root        26  0.0  0.0      0     0 ?        S    08:01   0:00 [watchdog/3]
root        27  0.0  0.0      0     0 ?        S    08:01   0:00 [migration/3]
root        28  0.0  0.0      0     0 ?        S    08:01   0:00 [ksoftirqd/3]
root        30  0.0  0.0      0     0 ?        S<   08:01   0:00 [kworker/3:0H]
root        31  0.0  0.0      0     0 ?        S    08:01   0:00 [kdevtmpfs]
root        32  0.0  0.0      0     0 ?        S<   08:01   0:00 [netns]
root        34  0.0  0.0      0     0 ?        S    08:01   0:01 [kworker/2:1]
root        35  0.0  0.0      0     0 ?        S    08:01   0:00 [oom_reaper]
root        36  0.0  0.0      0     0 ?        S<   08:01   0:00 [writeback]
root        37  0.0  0.0      0     0 ?        S    08:01   0:00 [kcompactd0]
root        38  0.0  0.0      0     0 ?        SN   08:01   0:00 [ksmd]
root        39  0.0  0.0      0     0 ?        S<   08:01   0:00 [crypto]
root        40  0.0  0.0      0     0 ?        S<   08:01   0:00 [kintegrityd]
root        41  0.0  0.0      0     0 ?        S<   08:01   0:00 [bioset]
root        42  0.0  0.0      0     0 ?        S<   08:01   0:00 [kblockd]
root        44  0.0  0.0      0     0 ?        S    08:01   0:01 [kworker/0:1]
root        45  0.0  0.0      0     0 ?        S<   08:01   0:00 [ata_sff]
root        46  0.0  0.0      0     0 ?        S<   08:01   0:00 [md]
root        47  0.0  0.0      0     0 ?        S<   08:01   0:00 [devfreq_wq]
root        48  0.0  0.0      0     0 ?        S<   08:01   0:00 [watchdogd]
root        50  0.0  0.0      0     0 ?        S    08:01   0:00 [kauditd]
```



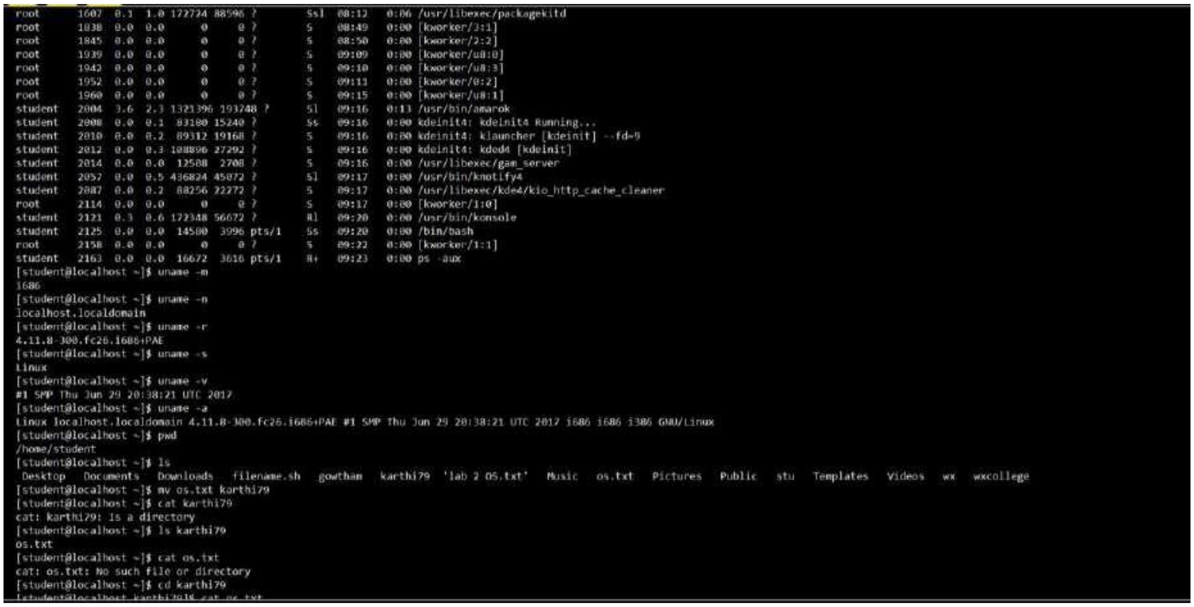
```
root        50  0.0  0.0      0     0 ?        S    08:01   0:00 [kauditd]
root        51  0.0  0.0      0     0 ?        S    08:01   0:00 [kswapd0]
root        52  0.0  0.0      0     0 ?        S<   08:01   0:00 [bioset]
root        99  0.0  0.0      0     0 ?        S<   08:01   0:00 [kthrotld]
root       100  0.0  0.0      0     0 ?        S<   08:01   0:00 [acpi_thermal_pm]
root       101  0.0  0.0      0     0 ?        S    08:01   0:00 [scsi_eh_0]
root       102  0.0  0.0      0     0 ?        S<   08:01   0:00 [scsi_tmf_0]
root       103  0.0  0.0      0     0 ?        S    08:01   0:00 [scsi_eh_1]
root       104  0.0  0.0      0     0 ?        S<   08:01   0:00 [scsi_tmf_1]
root       105  0.0  0.0      0     0 ?        S    08:01   0:00 [scsi_eh_2]
root       106  0.0  0.0      0     0 ?        S<   08:01   0:00 [scsi_tmf_2]
root       107  0.0  0.0      0     0 ?        S    08:01   0:00 [scsi_eh_3]
root       108  0.0  0.0      0     0 ?        S<   08:01   0:00 [scsi_tmf_3]
root       109  0.0  0.0      0     0 ?        S    08:01   0:00 [scsi_eh_4]
root       110  0.0  0.0      0     0 ?        S<   08:01   0:00 [scsi_tmf_4]
root       115  0.0  0.0      0     0 ?        S<   08:01   0:00 [dm_bufio_cache]
root       116  0.0  0.0      0     0 ?        S<   08:01   0:00 [ipv6_addrconf]
root       150  0.0  0.0      0     0 ?        S<   08:01   0:00 [bioset]
root       151  0.0  0.0      0     0 ?        S<   08:01   0:00 [bioset]
root       209  0.0  0.0      0     0 ?        S    08:01   0:01 [kworker/1:2]
root       355  0.0  0.0      0     0 ?        S<   08:01   0:00 [kworker/0:1H]
root       357  0.0  0.0      0     0 ?        S<   08:01   0:00 [kworker/1:1H]
root       363  0.0  0.0      0     0 ?        S<   08:01   0:00 [kworker/3:1H]
root       366  0.0  0.0      0     0 ?        S    08:01   0:00 [i915/signal:0]
root       367  0.0  0.0      0     0 ?        S    08:01   0:00 [i915/signal:1]
root       368  0.0  0.0      0     0 ?        S    08:01   0:00 [i915/signal:2]
root       369  0.0  0.0      0     0 ?        S    08:01   0:00 [i915/signal:4]
root       391  0.0  0.0      0     0 ?        S<   08:01   0:00 [kworker/2:1H]
root       428  0.0  0.0      0     0 ?        S<   08:01   0:00 [kdmflush]
root       429  0.0  0.0      0     0 ?        S<   08:01   0:00 [bioset]
root       441  0.0  0.0      0     0 ?        S<   08:01   0:00 [kdmflush]
root       442  0.0  0.0      0     0 ?        S<   08:01   0:00 [bioset]
root       459  0.0  0.0      0     0 ?        S    08:01   0:00 [jbd2/dm-0-8]
root       460  0.0  0.0      0     0 ?        S<   08:01   0:00 [ext4-rsv-conver]
root       544  0.0  0.1  42756  9240 ?        Ss   08:01   0:00 /usr/lib/systemd/systemd-journald
root       573  0.0  0.0  23956  8028 ?        Ss   08:01   0:00 /usr/lib/systemd/systemd-udevd
root       612  0.0  0.0      0     0 ?        S    08:01   0:00 [irq/32-mei_me]
root       652  0.0  0.0      0     0 ?        S    08:01   0:00 [jbd2/sda6-8]
root       653  0.0  0.0      0     0 ?        S<   08:01   0:00 [ext4-rsv-conver]
root       656  0.0  0.0      0     0 ?        S<   08:01   0:00 [kdmflush]
root       658  0.0  0.0      0     0 ?        S<   08:01   0:00 [bioset]
root       668  0.0  0.0      0     0 ?        S    08:01   0:00 [jbd2/dm-2-8]
root       669  0.0  0.0      0     0 ?        S<   08:01   0:00 [ext4-rsv-conver]
```



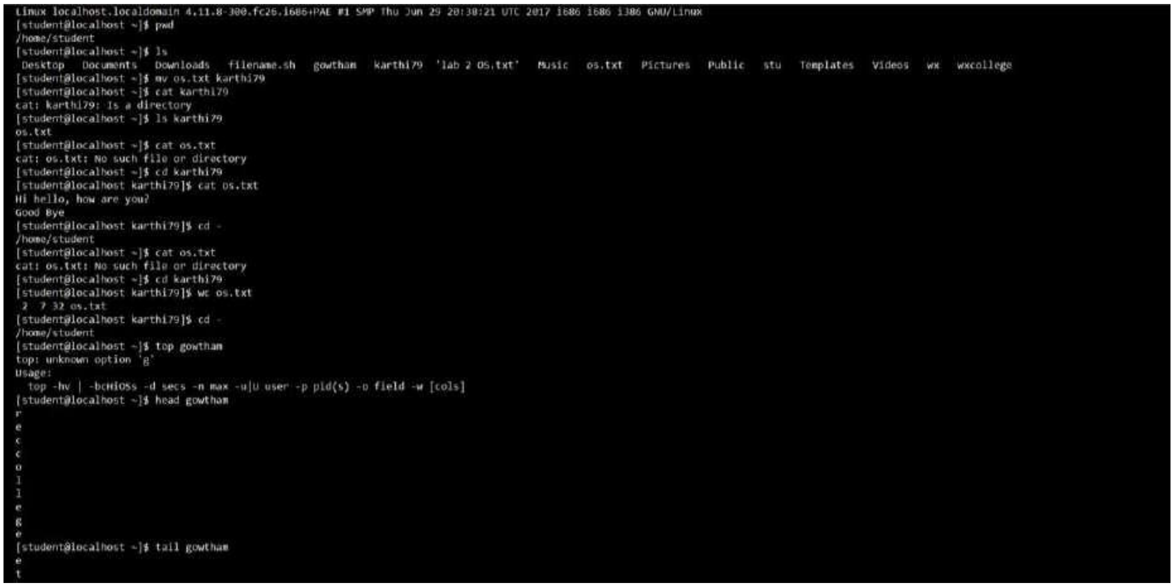
```
root       693  0.0  0.0      0     0 ?        S<   08:01   0:00 [xprtiod]
root       695  0.0  0.0  20388  1908 ?        S<sl 08:01   0:00 /sbin/auditd
root       714  0.0  0.0   4112  1384 ?        SNs  08:01   0:00 /usr/sbin/alsactl -s -n 19 -c -E ALSA_CONFIG_PATH=/etc/alsa/alsactl.conf --initfile=/lib/alsa/init/00main rdaemo
root       715  0.0  0.0  11100  2080 ?        Ss   08:01   0:00 /usr/sbin/mcelog --ignorenodev --daemon --foreground
root       716  0.0  0.1  50948  8392 ?        Ssl  08:01   0:00 /usr/sbin/ModemManager
root       718  0.0  0.1  38864  8420 ?        Ss   08:01   0:00 /usr/sbin/sssd -i -f
avahi      719  3.9  0.0  34632  7488 ?        Ss   08:01   3:15 avahi-daemon: running [linux-2.local]
root       720  0.0  0.0  14192  1384 ?        Ssl  08:01   0:00 /usr/sbin/irqbalance --foreground
dbus       721  0.0  0.0  40312  5520 ?        Ssl  08:01   0:00 /usr/bin/dbus-daemon --system --address=systemd: --nofork --nopidfile --systemd-activation --syslog-only
avahi      723  0.0  0.0  31204   276 ?        S    08:01   0:00 avahi-daemon: chroot helper
root       727  0.0  0.0  48856  3352 ?        Ssl  08:01   0:00 /usr/sbin/gssproxy -D
root       735  0.0  0.0  66048  5808 ?        Ssl  08:01   0:00 /usr/sbin/rsyslogd -n
root       736  0.0  0.0   5972  3896 ?        Ss   08:01   0:00 /usr/sbin/smartd -n -q never
root       738  0.0  0.3  43212 26920 ?        Ssl  08:01   0:00 /usr/bin/python3 -Es /usr/sbin/firewalld --nofork --nopid
rtkit      743  0.0  0.0  24164  3300 ?        SNsl 08:01   0:00 /usr/libexec/rtkit-daemon
root       748  0.0  0.1  63192  8468 ?        Ssl  08:01   0:00 /usr/sbin/abrtd -d -s
chrony     753  0.0  0.0  22396  3356 ?        S    08:01   0:00 /usr/sbin/chronyd
root       764  0.0  0.1  38936  9236 ?        S    08:01   0:00 /usr/libexec/sssd/sssd_be --domain implicit_files --uid 0 --gid 0 --debug-to-files
root       768  0.0  0.1  70260  9576 ?        Ss   08:01   0:00 /usr/bin/abrt-dump-journal-oops -fxtD
root       769  0.0  0.1  70224  8868 ?        Ss   08:01   0:00 /usr/bin/abrt-dump-journal-xorg -fxtD
root       770  0.0  0.1  70224  9412 ?        Ss   08:01   0:00 /usr/bin/abrt-dump-journal-core -D -T -f -e
root       771  0.0  0.3  44304 32760 ?        S    08:01   0:00 /usr/libexec/sssd/sssd_nss --uid 0 --gid 0 --debug-to-files
root       772  0.0  0.1  66456  8548 ?        Ssl  08:01   0:00 /usr/libexec/accounts-daemon
root       773  0.0  0.0  20680  8196 ?        Ss   08:01   0:00 /usr/lib/systemd/systemd-logind
root       788  0.0  0.2  83628 17480 ?        Ssl  08:01   0:00 /usr/sbin/NetworkManager --no-daemon
polkitd    780  0.0  0.1 104460 15588 ?        Ssl  08:01   0:00 /usr/lib/polkit-1/polkitd --no-debug
root       820  0.0  0.0  14776  3388 ?        Ss   08:01   0:00 /usr/sbin/crond -n
root       821  0.0  0.0  18104  2368 ?        Ss   08:01   0:00 /usr/sbin/atd -f
root       823  0.0  0.1  73100 13760 ?        Ssl  08:01   0:00 /usr/bin/sddm
root       884  0.2  0.6 103248 56960 tty1     Ssl+ 08:01   0:13 /usr/libexec/Xorg -nolisten tcp -auth /var/run/sddm/{28a38881-c890-485f-a7f8-244d759105bf} -background none -nor
root      1013  0.0  0.1  68208 10052 ?        Ssl  08:01   0:01 /usr/libexec/udisks2/udisksd
root      1019  0.0  0.0  46296  6272 ?        Ssl  08:01   0:00 /usr/libexec/upowerd
root      1058  0.0  0.1  61492 14076 ?        SL   08:12   0:00 /usr/libexec/sddm-helper --socket /tmp/sddm-auth856c3439-ee0d-4e78-a691-1f03713da942 --id 1 --start /usr/bin/sta
student   1062  0.0  0.0  20164  7616 ?        Ss   08:12   0:00 /usr/lib/systemd/systemd --user
student   1064  0.0  0.0  51884  2404 ?        S    08:12   0:00 (sd-pam)
student   1075  0.0  0.4 139196 33828 ?        Sl   08:12   0:00 /usr/bin/kwalletd5 --pam-login 4 17
student   1078  0.0  0.0   5784  3092 ?        S    08:12   0:00 /bin/sh /usr/bin/startkde
student   1097  0.0  0.0  33988  5888 ?        Ssl  08:12   0:00 /usr/bin/dbus-daemon --session --address=systemd: --nofork --nopidfile --systemd-activation --syslog-only
student   1102  0.0  0.0  10644   528 ?        Ss   08:12   0:00 /usr/bin/ssh-agent /bin/sh -c exec -l /bin/bash -c "/usr/bin/startkde"
student   1143  0.0  0.0   4468   120 ?        S    08:12   0:00 /usr/libexec/kf5/start_kdeinit --kded +kcminit_startup
student   1144  0.0  0.1  64524  8232 ?        Ss   08:12   0:00 kdeinit5: Running...
student   1145  0.0  0.3 122860 32328 ?        Sl   08:12   0:00 /usr/libexec/kf5/klauncher --fd=9
student   1148  0.0  0.7 277396 58832 ?        Sl   08:12   0:01 kded5 [kdeinit5]
student   1161  0.0  0.3 134144 31140 ?        Sl   08:12   0:00 /usr/bin/kaccess
```



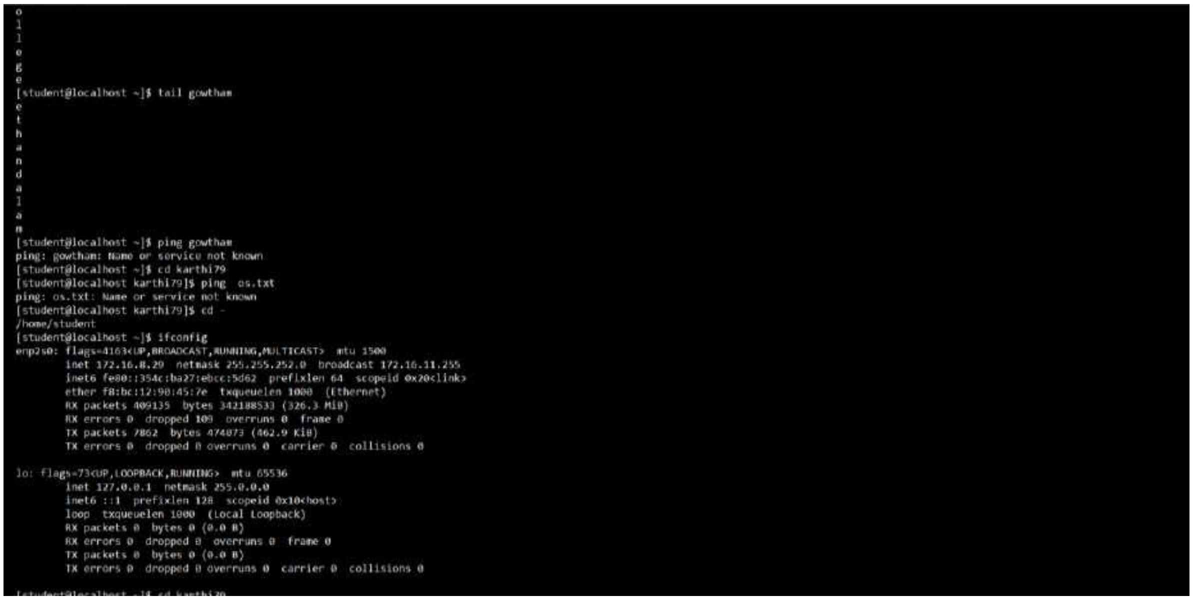
```
student   1173  0.0  0.4 146560 38380 ?        Sl   08:12   0:00 /usr/bin/ksmserver
student   1178  0.0  0.3 123464 31244 ?        Sl   08:12   0:00 /usr/bin/kglobalaccel5
student   1183  0.0  0.1  58076 11780 ?        Sl   08:12   0:00 /usr/libexec/mission-control-5
colord    1185  0.0  0.1  53116 11664 ?        Ssl  08:12   0:00 /usr/libexec/colord
student   1191  0.3  0.9 316792 79436 ?        Sl   08:12   0:13 kwin_x11
student   1205  0.0  0.2  80824 17476 ?        Sl   08:12   0:00 /usr/libexec/kf5/kscreen_backend_launcher
student   1210  0.0  0.2 1125568 17704 ?       SNl  08:12   0:00 /usr/bin/baloo_file
student   1212  0.0  0.4 151940 40124 ?        Sl   08:12   0:00 /usr/libexec/kdeconnectd
student   1214  0.0  1.2 1385220 99496 ?       Sl   08:12   0:01 /usr/bin/krunner
student   1216  0.3  2.5 1018156 210240 ?      Sl   08:12   0:15 /usr/bin/plasmashell
student   1217  0.0  0.4 157596 35264 ?        Sl   08:12   0:00 /usr/libexec/kf5/polkit-kde-authentication-agent-1
student   1218  0.0  0.3 129832 30440 ?        Sl   08:12   0:00 /usr/bin/xembedsniproxy
root      1269  0.0  0.0      0     0 ?        S    08:12   0:01 [kworker/3:0]
student   1279  0.0  0.1 1404256 10852 ?       S<l  08:12   0:00 /usr/bin/pulseaudio --start --log-target=syslog
student   1296  0.0  0.2  78068 23864 ?        Sl   08:12   0:00 /usr/bin/abrt-applet
student   1298  0.0  0.7 349124 65560 ?        Sl   08:12   0:00 /usr/bin/korgac
student   1299  0.0  0.4 151080 35844 ?        Sl   08:12   0:00 /usr/libexec/org_kde_powerdevil
student   1328  0.0  0.4 193268 35960 ?        Sl   08:12   0:00 /usr/bin/kactivitymanagerd start-daemon
student   1371  0.0  0.0  48172  7160 ?        Ssl  08:12   0:00 /usr/libexec/at-spi-bus-launcher
student   1381  0.0  0.0  33240  4660 ?        Sl   08:12   0:00 /bin/dbus-daemon --config-file=/usr/share/defaults/at-spi2/accessibility.conf --nofork --print-address 3
student   1386  0.0  0.0  30076  6560 ?        Sl   08:12   0:00 /usr/libexec/at-spi2-registryd --use-gnome-session
root      1446  0.0  0.0  55488  8116 ?        Sl   08:12   0:00 /usr/sbin/abrt-dbus -t133
student   1452  0.0  0.3 130748 31828 ?        Sl   08:12   0:00 /usr/bin/akonadi_control
student   1456  0.0  0.3 344108 28140 ?        Sl   08:12   0:00 akonadiserver
student   1459  0.0  0.6 526992 55356 ?        Sl   08:12   0:02 /usr/libexec/mysqld --defaults-file=/home/student/.local/share/akonadi/mysql.conf --datadir=/home/student/.local
student   1499  0.0  0.4 145168 36240 ?        Sl   08:12   0:00 /usr/bin/akonadi_akonotes_resource --identifier akonadi_akonotes_resource_0
student   1500  0.0  0.7 345544 64868 ?        Sl   08:12   0:00 /usr/bin/akonadi_archivemail_agent --identifier akonadi_archivemail_agent
student   1501  0.0  0.4 150136 38044 ?        Sl   08:12   0:00 /usr/bin/akonadi_birthdays_resource --identifier akonadi_birthdays_resource
student   1502  0.0  0.4 144012 36384 ?        Sl   08:12   0:00 /usr/bin/akonadi_contacts_resource --identifier akonadi_contacts_resource_0
student   1503  0.0  0.4 160016 39700 ?        Sl   08:12   0:00 /usr/bin/akonadi_followupreminder_agent --identifier akonadi_followupreminder_agent
student   1504  0.0  0.4 151472 38864 ?        Sl   08:12   0:00 /usr/bin/akonadi_ical_resource --identifier akonadi_ical_resource_0
student   1507  0.0  0.4 154560 40440 ?        SNl  08:12   0:00 /usr/bin/akonadi_indexing_agent --identifier akonadi_indexing_agent
student   1510  0.0  0.4 145168 35732 ?        Sl   08:12   0:00 /usr/bin/akonadi_maildir_resource --identifier akonadi_maildir_resource_0
student   1529  0.0  0.4 155640 37248 ?        Sl   08:12   0:00 /usr/bin/akonadi_maildispatcher_agent --identifier akonadi_maildispatcher_agent
student   1530  0.0  0.8 351476 67804 ?        Sl   08:12   0:00 /usr/bin/akonadi_mailfilter_agent --identifier akonadi_mailfilter_agent
student   1531  0.0  0.4 144376 36524 ?        Sl   08:12   0:00 /usr/bin/akonadi_migration_agent --identifier akonadi_migration_agent
student   1532  0.0  0.7 317728 58360 ?        Sl   08:12   0:00 /usr/bin/akonadi_newmailnotifier_agent --identifier akonadi_newmailnotifier_agent
student   1533  0.0  0.7 343160 63856 ?        Sl   08:12   0:00 /usr/bin/akonadi_sendlater_agent --identifier akonadi_sendlater_agent
student   1601  0.0  0.3 130504 32776 ?        Sl   08:12   0:00 /usr/bin/kuiserver5
root      1605  0.0  0.0  31532  7876 ?        Ss   08:12   0:00 /usr/sbin/cupsd -l
root      1607  0.1  1.0 172724 88596 ?        Ssl  08:12   0:06 /usr/libexec/packagekitd
root      1838  0.0  0.0      0     0 ?        S    08:49   0:00 [kworker/3:1]
root      1845  0.0  0.0      0     0 ?        S    08:50   0:00 [kworker/2:2]
root      1939  0.0  0.0      0     0 ?        S    09:00   0:00 [kworker/u8:0]
```



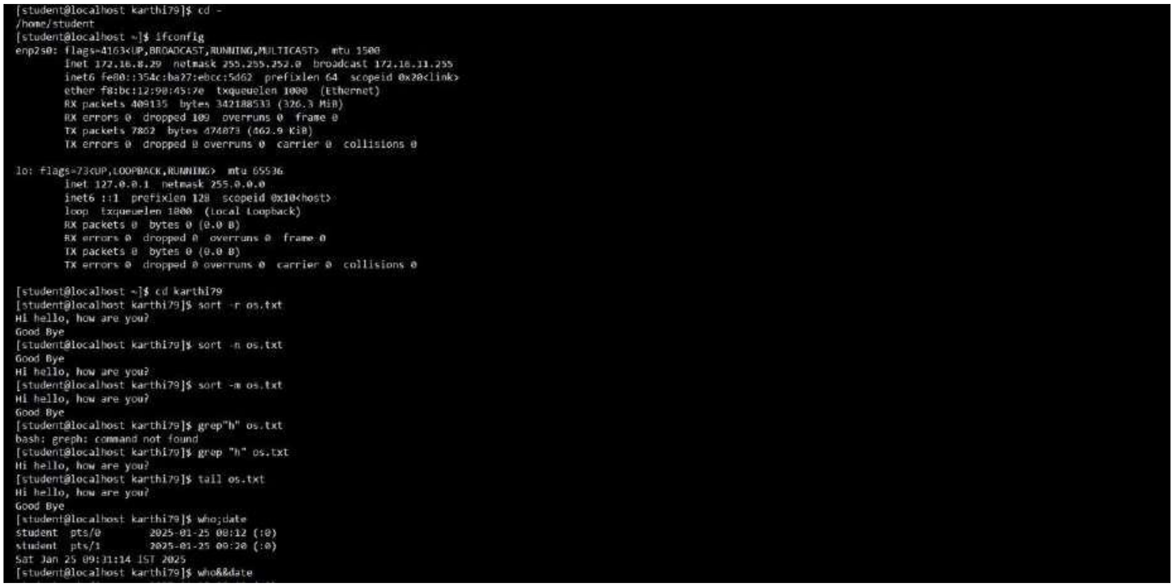
```
root      1607  0.1  1.0 172724 88596 ?        Ssl  08:12   0:06 /usr/libexec/packagekitd
root      1838  0.0  0.0      0     0 ?        S    08:49   0:00 [kworker/3:1]
root      1845  0.0  0.0      0     0 ?        S    08:50   0:00 [kworker/2:2]
root      1939  0.0  0.0      0     0 ?        S    09:09   0:00 [kworker/u8:0]
root      1942  0.0  0.0      0     0 ?        S    09:10   0:00 [kworker/u8:3]
root      1952  0.0  0.0      0     0 ?        S    09:11   0:00 [kworker/0:2]
root      1960  0.0  0.0      0     0 ?        S    09:15   0:00 [kworker/u8:1]
student   2004  3.6  2.3 1321396 193748 ?      Sl   09:16   0:13 /usr/bin/amarok
student   2008  0.0  0.1  83180 15240 ?        Ss   09:16   0:00 kdeinit4: kdeinit4 Running...
student   2010  0.0  0.2  89312 19168 ?        S    09:16   0:00 kdeinit4: klauncher [kdeinit] --fd=9
student   2012  0.0  0.3 108896 27292 ?        S    09:16   0:00 kdeinit4: kded4 [kdeinit]
student   2014  0.0  0.0  12508  2708 ?        S    09:16   0:00 /usr/libexec/gam_server
student   2057  0.0  0.5 436824 45072 ?        Sl   09:17   0:00 /usr/bin/knotify4
student   2087  0.0  0.2  88256 22272 ?        S    09:17   0:00 /usr/libexec/kde4/kio_http_cache_cleaner
root      2114  0.0  0.0      0     0 ?        S    09:17   0:00 [kworker/1:0]
student   2121  0.3  0.6 172348 56672 ?        Rl   09:20   0:00 /usr/bin/konsole
student   2125  0.0  0.0  14500  3996 pts/1    Ss   09:20   0:00 /bin/bash
root      2158  0.0  0.0      0     0 ?        S    09:22   0:00 [kworker/1:1]
student   2163  0.0  0.0  16672  3616 pts/1    R+   09:23   0:00 ps -aux
[student@localhost ~]$ uname -m
i686
[student@localhost ~]$ uname -n
localhost.localdomain
[student@localhost ~]$ uname -r
4.11.8-300.fc26.i686+PAE
[student@localhost ~]$ uname -s
Linux
[student@localhost ~]$ uname -v
#1 SMP Thu Jun 29 20:38:21 UTC 2017
[student@localhost ~]$ uname -a
Linux localhost.localdomain 4.11.8-300.fc26.i686+PAE #1 SMP Thu Jun 29 20:38:21 UTC 2017 i686 i686 i386 GNU/Linux
[student@localhost ~]$ pwd
/home/student
[student@localhost ~]$ ls
 Desktop   Documents   Downloads   filename.sh   gowtham   karthi79  'lab 2 OS.txt'   Music   os.txt   Pictures   Public   stu   Templates   Videos   wx   wxcollege
[student@localhost ~]$ mv os.txt karthi79
[student@localhost ~]$ cat karthi79
cat: karthi79: Is a directory
[student@localhost ~]$ ls karthi79
os.txt
[student@localhost ~]$ cat os.txt
cat: os.txt: No such file or directory
[student@localhost ~]$ cd karthi79
[student@localhost karthi79]$ cat os.txt
```



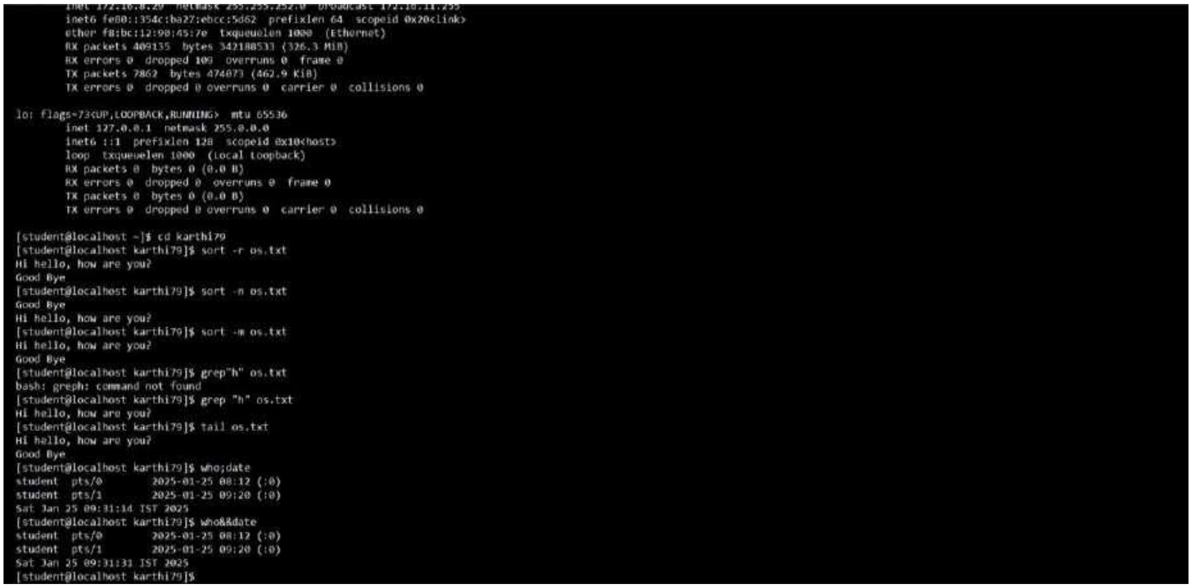
```
Linux localhost.localdomain 4.11.8-300.fc26.i686+PAE #1 SMP Thu Jun 29 20:38:21 UTC 2017 i686 i686 i386 GNU/Linux
[student@localhost ~]$ pwd
/home/student
[student@localhost ~]$ ls
 Desktop   Documents   Downloads   filename.sh   gowtham   karthi79  'lab 2 OS.txt'   Music   os.txt   Pictures   Public   stu   Templates   Videos   wx   wxcollege
[student@localhost ~]$ mv os.txt karthi79
[student@localhost ~]$ cat karthi79
cat: karthi79: Is a directory
[student@localhost ~]$ ls karthi79
os.txt
[student@localhost ~]$ cat os.txt
cat: os.txt: No such file or directory
[student@localhost ~]$ cd karthi79
[student@localhost karthi79]$ cat os.txt
Hi hello, how are you?
Good Bye
[student@localhost karthi79]$ cd -
/home/student
[student@localhost ~]$ cat os.txt
cat: os.txt: No such file or directory
[student@localhost ~]$ cd karthi79
[student@localhost karthi79]$ wc os.txt
 2  7 32 os.txt
[student@localhost karthi79]$ cd -
/home/student
[student@localhost ~]$ top gowtham
top: unknown option 'g'
Usage:
  top -hv | -bcHiOSs -d secs -n max -u|U user -p pid(s) -o field -w [cols]
[student@localhost ~]$ head gowtham
r
e
c
c
o
l
l
e
g
e
[student@localhost ~]$ tail gowtham
e
t
```



```
o
l
l
e
g
e
[student@localhost ~]$ tail gowtham
e
t
h
a
n
d
a
l
a
m
[student@localhost ~]$ ping gowtham
ping: gowtham: Name or service not known
[student@localhost ~]$ cd karthi79
[student@localhost karthi79]$ ping  os.txt
ping: os.txt: Name or service not known
[student@localhost karthi79]$ cd -
/home/student
[student@localhost ~]$ ifconfig
enp2s0: flags=4163<UP,BROADCAST,RUNNING,MULTICAST>  mtu 1500
        inet 172.16.8.29  netmask 255.255.252.0  broadcast 172.16.11.255
        inet6 fe80::354c:ba27:ebcc:5d62  prefixlen 64  scopeid 0x20<link>
        ether f8:bc:12:90:45:7e  txqueuelen 1000  (Ethernet)
        RX packets 409135  bytes 342188533 (326.3 MiB)
        RX errors 0  dropped 109  overruns 0  frame 0
        TX packets 7862  bytes 474073 (462.9 KiB)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0

lo: flags=73<UP,LOOPBACK,RUNNING>  mtu 65536
        inet 127.0.0.1  netmask 255.0.0.0
        inet6 ::1  prefixlen 128  scopeid 0x10<host>
        loop  txqueuelen 1000  (Local Loopback)
        RX packets 0  bytes 0 (0.0 B)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 0  bytes 0 (0.0 B)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0

[student@localhost ~]$ cd karthi79
```



```
[student@localhost karthi79]$ cd -
/home/student
[student@localhost ~]$ ifconfig
enp2s0: flags=4163<UP,BROADCAST,RUNNING,MULTICAST>  mtu 1500
        inet 172.16.8.29  netmask 255.255.252.0  broadcast 172.16.11.255
        inet6 fe80::354c:ba27:ebcc:5d62  prefixlen 64  scopeid 0x20<link>
        ether f8:bc:12:90:45:7e  txqueuelen 1000  (Ethernet)
        RX packets 409135  bytes 342188533 (326.3 MiB)
        RX errors 0  dropped 109  overruns 0  frame 0
        TX packets 7862  bytes 474073 (462.9 KiB)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0

lo: flags=73<UP,LOOPBACK,RUNNING>  mtu 65536
        inet 127.0.0.1  netmask 255.0.0.0
        inet6 ::1  prefixlen 128  scopeid 0x10<host>
        loop  txqueuelen 1000  (Local Loopback)
        RX packets 0  bytes 0 (0.0 B)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 0  bytes 0 (0.0 B)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0

[student@localhost ~]$ cd karthi79
[student@localhost karthi79]$ sort -r os.txt
Hi hello, how are you?
Good Bye
[student@localhost karthi79]$ sort -n os.txt
Good Bye
Hi hello, how are you?
[student@localhost karthi79]$ sort -m os.txt
Hi hello, how are you?
Good Bye
[student@localhost karthi79]$ grep"h" os.txt
bash: greph: command not found
[student@localhost karthi79]$ grep "h" os.txt
Hi hello, how are you?
[student@localhost karthi79]$ tail os.txt
Hi hello, how are you?
Good Bye
[student@localhost karthi79]$ who;date
student  pts/0        2025-01-25 08:12 (:0)
student  pts/1        2025-01-25 08:20 (:0)
Sat Jan 25 09:31:14 IST 2025
[student@localhost karthi79]$ who&&date
```



```
        inet 172.16.8.29  netmask 255.255.252.0  broadcast 172.16.11.255
        inet6 fe80::354c:ba27:ebcc:5d62  prefixlen 64  scopeid 0x20<link>
        ether f8:bc:12:98:45:7e  txqueuelen 1000  (Ethernet)
        RX packets 409135  bytes 342188533 (326.3 MiB)
        RX errors 0  dropped 109  overruns 0  frame 0
        TX packets 7862  bytes 474073 (462.9 KiB)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0

lo: flags=73<UP,LOOPBACK,RUNNING>  mtu 65536
        inet 127.0.0.1  netmask 255.0.0.0
        inet6 ::1  prefixlen 128  scopeid 0x10<host>
        loop  txqueuelen 1000  (Local Loopback)
        RX packets 0  bytes 0 (0.0 B)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 0  bytes 0 (0.0 B)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0

[student@localhost ~]$ cd karthi79
[student@localhost karthi79]$ sort -r os.txt
Hi hello, how are you?
Good Bye
[student@localhost karthi79]$ sort -n os.txt
Good Bye
Hi hello, how are you?
[student@localhost karthi79]$ sort -m os.txt
Hi hello, how are you?
Good Bye
[student@localhost karthi79]$ grep"h" os.txt
bash: greph: command not found
[student@localhost karthi79]$ grep "h" os.txt
Hi hello, how are you?
[student@localhost karthi79]$ tail os.txt
Hi hello, how are you?
Good Bye
[student@localhost karthi79]$ who;date
student  pts/0        2025-01-25 08:12 (:0)
student  pts/1        2025-01-25 09:20 (:0)
Sat Jan 25 09:31:14 IST 2025
[student@localhost karthi79]$ who&&date
student  pts/0        2025-01-25 08:12 (:0)
student  pts/1        2025-01-25 09:20 (:0)
Sat Jan 25 09:31:31 IST 2025
[student@localhost karthi79]$
```

RESULT:

Thus, the program of basic Linux commands has been executed and the output has been verified.

2116231801082

Ex. No: 2a
Date: 24/1/25

Shell Script

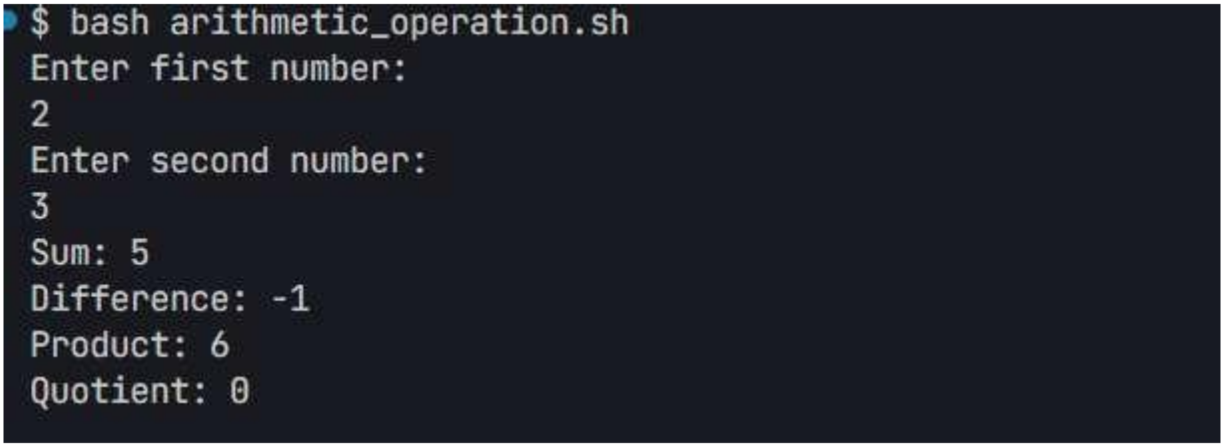
AIM:

To write a Shell script to display a basic calculator.

PROGRAM:

```
#!/bin/bash

while true; do
    echo "========================"
    echo "     Basic Calculator"
    echo "========================"
    echo "1. Addition"
    echo "2. Subtraction"
    echo "3. Multiplication"
    echo "4. Division"
    echo "5. Exit"
    echo -n "Choose an option (1-5): "
    read choice

    if [[ $choice -eq 5 ]]; then
        echo "Exiting Calculator. Goodbye!"
        exit 0
    fi

    echo -n "Enter first number: "
    read num1
    echo -n "Enter second number: "
    read num2

    case $choice in
        1) result=$((num1 + num2))
           echo "Result: $num1 + $num2 = $result"
           ;;
        2) result=$((num1 - num2))
           echo "Result: $num1 - $num2 = $result"
           ;;
        3) result=$((num1 * num2))
           echo "Result: $num1 * $num2 = $result"
           ;;
        4) if [[ $num2 -eq 0 ]]; then
              echo "Error: Division by zero is not allowed!"
           else

              result=$(awk "BEGIN {print $num1 / $num2}")
              echo "Result: $num1 / $num2 = $result"
           fi
           ;;
        *) echo "Invalid option! Please choose between 1-5."
           ;;
    esac
    echo "--------------------------"
    echo ""
done
```

OUTPUT:



```
$ bash arithmetic_operation.sh
Enter first number:
2
Enter second number:
3
Sum: 5
Difference: -1
Product: 6
Quotient: 0
```

RESULT:

Thus, the basic calculator program was successfully implemented using shell scripting.

2116231801082

Ex. No: 2b
Date: 24/1/25

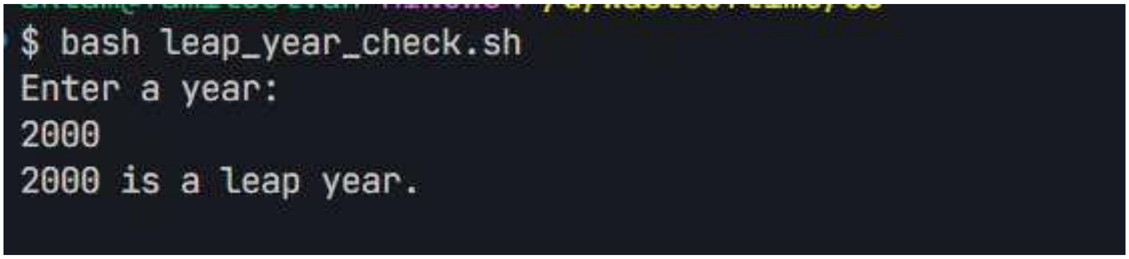
Shell Script

AIM:
To write a Shellscript to test given year is leap or not using conditional statement

PROGRAM:

```
#!/bin/bash

read -p "Enter year: " year

if (( year % 4 == 0 && year % 100 != 0 )) || (( year % 400 == 0 )); then
                        echo "$year is a Leap Year"
else
                        echo "$year is not a Leap Year"
fi
```

OUTPUT:



```
$ bash leap_year_check.sh
Enter a year:
2000
2000 is a leap year.
```

RESULT:

Thus, the leap year program was successfully implemented using shell scripting.

Ex. No: 3a
Date: 28/1/25

Shell Script – Reverse of Digit

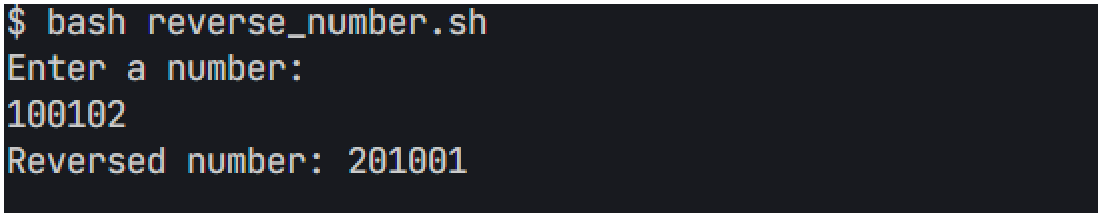
AIM:

To write a Shell script to reverse a given digit using looping statement.

PROGRAM:

```
#!/bin/bash

read -p "Enter a number: " num

reverse=0
while [ $num -gt 0 ]; do
        digit=$(( num % 10 ))
        reverse=$(( reverse * 10 + digit ))
        num=$(( num / 10 ))
done

echo "Reversed number: $reverse"
```

OUTPUT:



```
$ bash reverse_number.sh
Enter a number:
100102
Reversed number: 201001
```

RESULT:

Thus, the shell script to reverse a given digit is successfully implemented.

2116231801082

Ex. No: 3b
Date: 28/1/25

Shell Script – Fibonacci Series

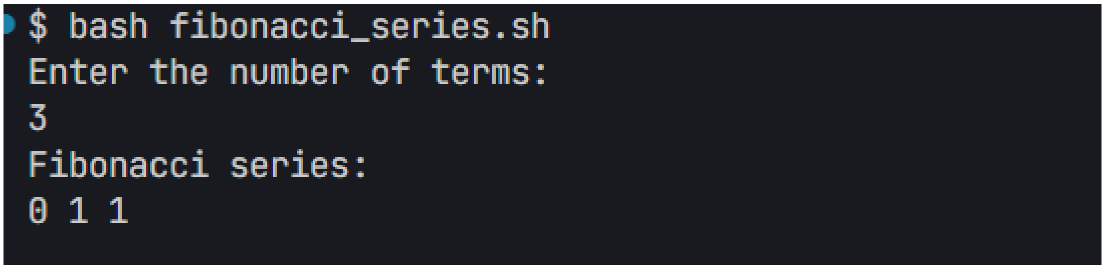
AIM:

To write a Shell script to generate a Fibonacci series using a for loop.

PROGRAM:

```
#!/bin/bash

read -p "Enter the number of terms: " n
a=0
b=1

echo "Fibonacci Series:"
for (( i=0; i<n; i++ )); do
        echo -n "$a "
            temp=$((a + b))
            a=$b
            b=$temp
done

echo
```

OUTPUT



```
$ bash fibonacci_series.sh
Enter the number of terms:
3
Fibonacci series:
0 1 1
```

RESULT:

Thus, the Shell Script to generate the Fibonacci series is successfully implemented.

Ex. No: 4a
Date: 3/2/25

EMPLOYEE AVERAGE PAY

AIM:

To find out the average pay of all employees whose salary is more than 6000 and no. of days worked is more than 4.

ALGORITHM:

1. Create a flat file emp.dat for employees with their name, salary per day and number of days worked and save it.
2. Create an awk script emp.awk
3. For each employee record do
a. If the Salary is greater than 6000 and number of days worked is more than 4, then print the name and salary earned
b. Compute total pay of employee
4. Print the total number of employees satisfying the criteria and their average pay.

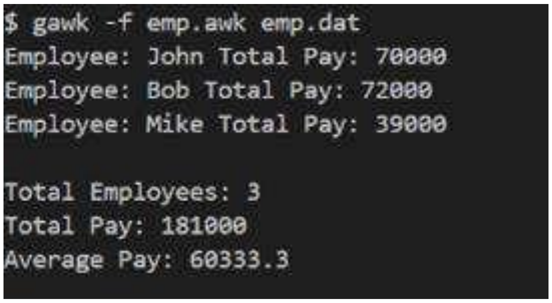
PROGRAM:

```
#!/usr/bin/awk -f


BEGIN {
count = 0;
total_pay = 0;
}

{
salary = $2;
days = $3;

if (salary > 6000 && days > 4) {
pay = salary * days;
print "Employee:", $1, "Total Pay:", pay;
total_pay += pay;
count++;
}
}

END {
if (count > 0) {
avg_pay = total_pay / count;
print "\nTotal Employees:", count;
print "Total Pay:", total_pay;
print "Average Pay:", avg_pay;
} else {
print "No employees satisfy the criteria.";
}
}
```

INPUT:

John 7000 10
Alice 5000 12
Bob 8000 9
Mike 6500 6

OUTPUT:



```
$ gawk -f emp.awk emp.dat
Employee: John Total Pay: 70000
Employee: Bob Total Pay: 72000
Employee: Mike Total Pay: 39000

Total Employees: 3
Total Pay: 181000
Average Pay: 60333.3
```

RESULT:

Thus, to find the average salary whose salary is above 6000 is successfully implemented.

Ex. No: 4b

Date: 3/2/25

RESULTS OF EXAMINATION

AIM:

To print the pass/fail status of a student in a class.

ALGORITHM:

```
1. Read the data from file
2. Get a data from each column
3. Compare the all subject marks column
    a. If marks less than 45 then print Fail
    b. else print Pass
```

PROGRAM:

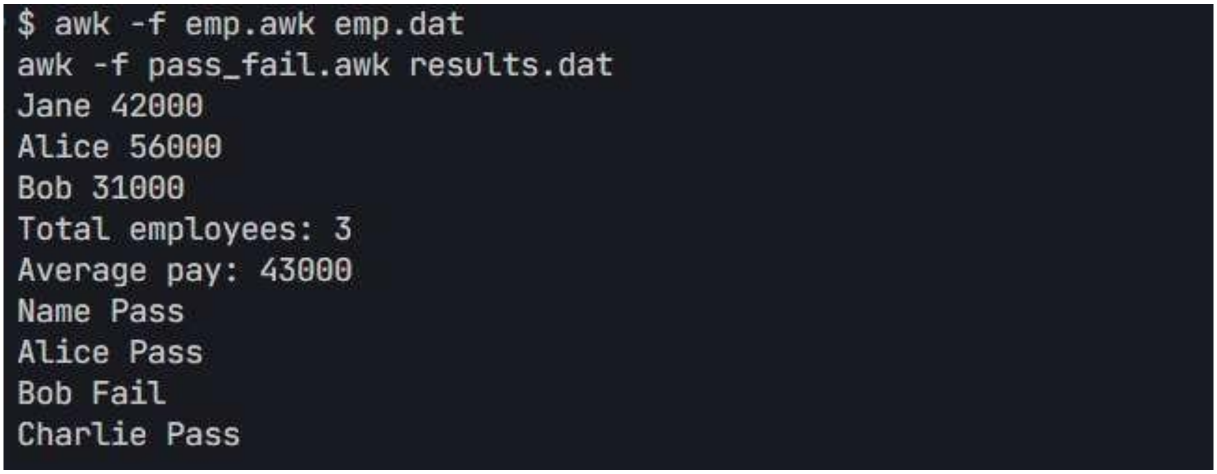
```
//marks.awk
#!/usr/bin/gawk -f
{
name = $1;
pass =  1;
for (i = 2; i <= NF; i++) {
if ($i < 45) {
pass = 0;
break;}
}
if(pass) {
print name, "Pass";
} else {
print name, "Fail";}
}
```

INPUT:

//marks.dat

```
John  50  60  45  70  80
Alice 40  55  30  65  75
Bob   80  85  90  78  88
Mike  35  40  50  60  45
```

OUTPUT:



```
$ awk -f emp.awk emp.dat
awk -f pass_fail.awk results.dat
Jane 42000
Alice 56000
Bob 31000
Total employees: 3
Average pay: 43000
Name Pass
Alice Pass
Bob Fail
Charlie Pass
```

RESULT:

Thus, to print the Pass/Fail Status of a student in a class is successfully implemented.

Ex. No: 5
Date: 8/2/25

System Calls Programming

AIM:

To experiment system calls using fork(), execlp() and pid() functions.

ALGORITHM:

1. **Start**
2. **Include Header Files**
    - Include stdio.h for input/output functions
    - Include stdlib.h for general utility functions
3. **Variable Declaration**
    - Declare an integer variable pid to store the process ID returned by fork()
4. **Create a New Process**
    - Call the fork() function and assign its return value to pid
        - If fork() returns:
            - -1: Process creation failed
            - 0: This is the **child** process
            - A positive integer: This is the **parent** process
5. **Print Statement Executed by Both Processes**
    - Print: "THIS LINE EXECUTED TWICE"
6. **Check for Process Creation Failure**
    - If pid == -1:
        - Print: "CHILD PROCESS NOT CREATED"
        - Exit the program using exit(0)
7. **Child Process Execution Block**
    - If pid == 0:
        - Print:
            - "Process ID of child: " followed by getpid()
            - "Parent Process ID of child: " followed by getppid()
8. **Parent Process Execution Block**
    - If pid > 0:
        - Print:
            - "Process ID of parent: " followed by getpid()
            - "Parent’s Parent Process ID: " followed by getppid()
9. **Final Print Statement (Executed by Both Processes)**

- Print: objectives

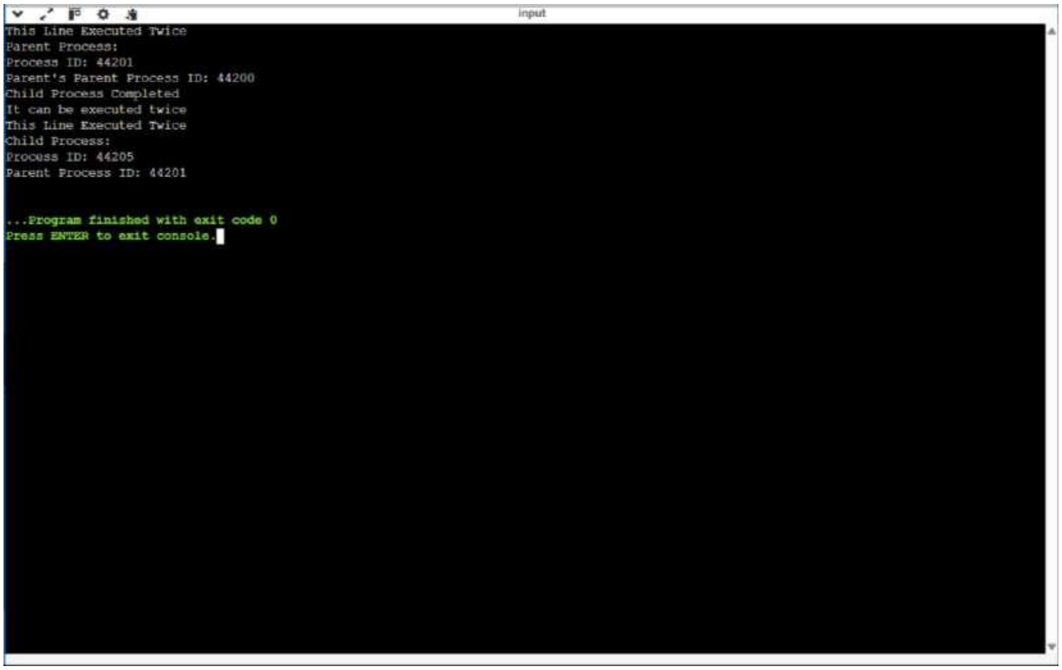
IT CAN BE EXECUTED TWICE

10. **End**

PROGRAM:

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

int main() {
    int pid;
    pid = fork();
    printf("This Line Executed Twice\n");

    if (pid < 0) {
        printf("Child Process Not Created\n");
        exit(1);
    }

    if (pid == 0) {
        printf("Child Process:\n");
        printf("Process ID: %d\n", getpid());
        printf("Parent Process ID: %d\n", getppid());
        execlp("/bin/ls", "ls", NULL);
        perror("execlp failed");
        exit(1);
     } else { // Parent process
            printf("Parent Process:\n");
            printf("Process ID: %d\n", getpid());
            printf("Parent's Parent Process ID: %d\n", getppid());
            printf("Child Process Completed\n");
      }

      printf("It can be executed twice\n");

      return 0;
}
```

OUTPUT:



```
This Line Executed Twice
Parent Process:
Process ID: 44201
Parent's Parent Process ID: 44200
Child Process Completed
It can be executed twice
This Line Executed Twice
Child Process:
Process ID: 44205
Parent Process ID: 44201


...Program finished with exit code 0
Press ENTER to exit console.
```

RESULT:

Thus, the Program is implemented using fork(),execlp() and pid() Function.

Ex. No: 6a
Date: 15/2/25

FIRST COME FIRST SERVE

AIM:

To implement First-come First- serve (FCFS) scheduling technique

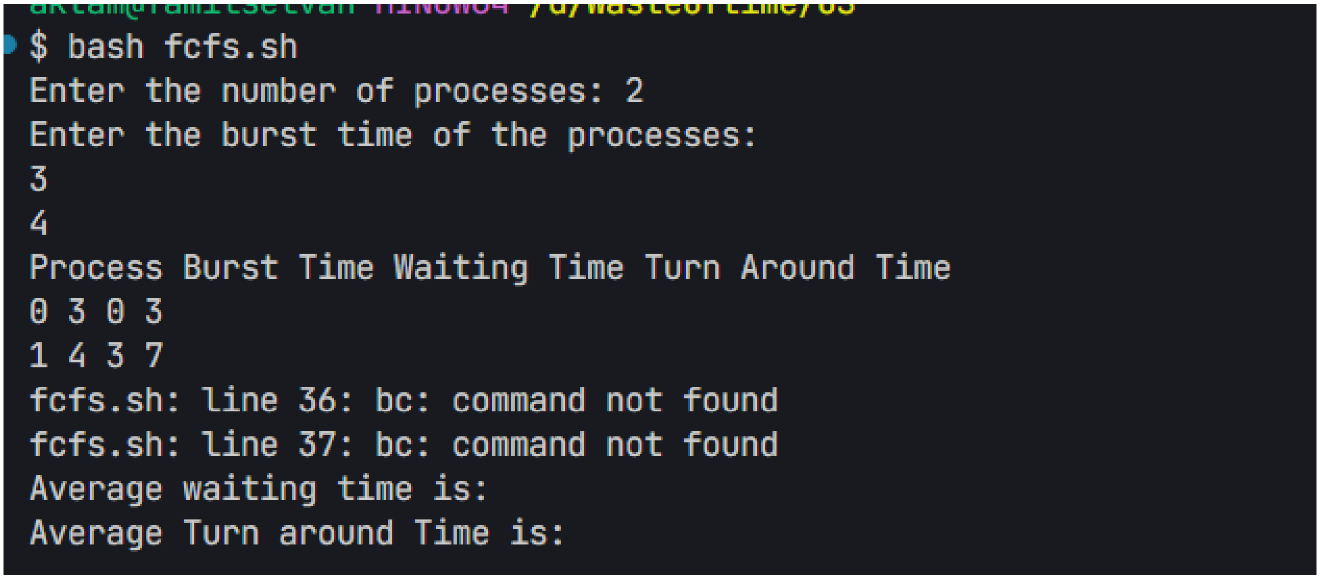
ALGORITHM**:**

1. Get the number of processes from the user.
2. Read the process name and burst time.
3. Calculate the total process time.
4. Calculate the total waiting time and total turnaround time for each process
5. Display the process name & burst time for each process.
6. Display the total waiting time, average waiting time, turnaround time.

PROGRAM:

```
#include <stdio.h>

int main() {
int pid[15], bt[15], wt[15], n;
float twt = 0, ttat = 0;

printf("Enter the number of processes: ");
scanf("%d", &n);

printf("Enter process ID of all the processes:\n");
for (int i = 0; i < n; i++) {
scanf("%d", &pid[i]);
}

printf("Enter burst time of all the processes:\n");
for (int i = 0; i < n; i++) {
scanf("%d", &bt[i]);
}

wt[0] = 0;
// Calculate waiting time for all other processes
for (int i = 1; i < n; i++) {
wt[i] = wt[i - 1] + bt[i - 1];
}

printf("\nProcess ID\tBurst Time\tWaiting Time\tTurnaround Time\n");
for (int i = 0; i < n; i++) {
int tat = bt[i] + wt[i];
twt += wt[i];
ttat += tat;

printf("%d\t\t%d\t\t%d\t\t%d\n", pid[i], bt[i], wt[i], tat);
}

printf("\nAverage waiting time = %.2f\n", twt / n);
printf("Average turnaround time = %.2f\n", ttat / n);

return 0;
}
```

OUTPUT:



```
aktam@tamilselvan MINGW64 /d/wasteoftime/os
$ bash fcfs.sh
Enter the number of processes: 2
Enter the burst time of the processes:
3
4
Process Burst Time Waiting Time Turn Around Time
0 3 0 3
1 4 3 7
fcfs.sh: line 36: bc: command not found
fcfs.sh: line 37: bc: command not found
Average waiting time is:
Average Turn around Time is:
```

RESULT:

Thus, the Program of first come first serve is successfully implemented.

Ex. No: 6b
Date: 15/2/25

SHORTEST JOB FIRST

AIM:

To implement the Shortest Job First (SJF) scheduling technique

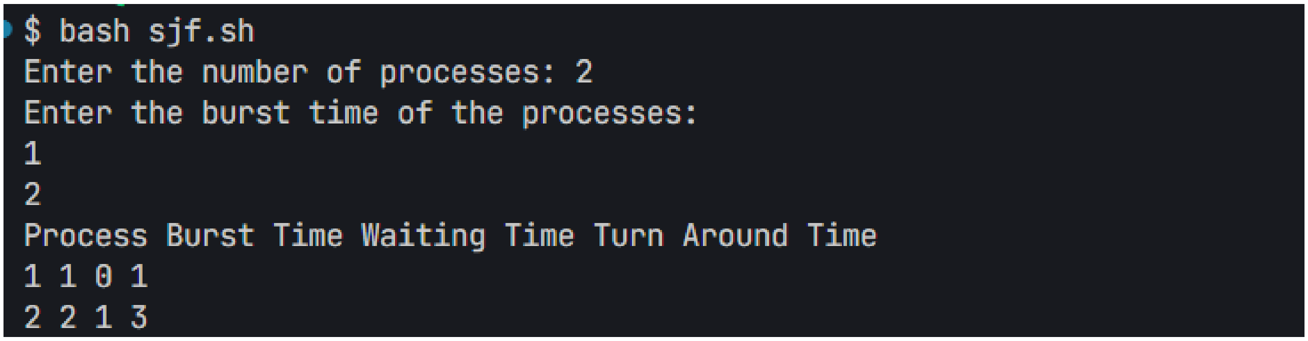
ALGORITHM:

1. Declare the structure and its elements.
2. Get a number of processes as input from the user.
3. Read the process name, arrival time and burst time
4. Initialize waiting time, turnaround time & flag of read processes to zero.
5. Sort based on the burst time of all processes in ascending order.
6. Calculate the waiting time and turnaround time for each process.
7. Calculate the average waiting time and average turnaround time.
8. Display the results.

PROGRAM:

```
#include <stdio.h>

int main() {
int A[100][4]; // A[i][0]=PID, A[i][1]=BT, A[i][2]=WT, A[i][3]=TAT
int i, j, n, total = 0, index, temp;
float avg_wt, avg_tat;

printf("Enter number of processes: ");
scanf("%d", &n);

printf("Enter Burst Time:\n");
for (i = 0; i < n; i++) {
printf("P%d: ", i + 1);
scanf("%d", &A[i][1]);
A[i][0] = i + 1; // Assign process ID
}


for (i = 0; i < n; i++) {
index = i;
for (j = i + 1; j < n; j++) {
if (A[j][1] < A[index][1])
index = j;
}


temp = A[i][1];
A[i][1] = A[index][1];
A[index][1] = temp;


temp = A[i][0];
A[i][0] = A[index][0];
A[index][0] = temp;
}

A[0][2] = 0;
for (i = 1; i < n; i++) {
A[i][2] = 0;
for (j = 0; j < i; j++) {
A[i][2] += A[j][1];
}
total += A[i][2];
}
avg_wt = (float) total / n;


total = 0;
printf("\nProcess\tBT\tWT\tTAT\n");
for (i = 0; i < n; i++) {
A[i][3] = A[i][1] + A[i][2]; // TAT = BT + WT
total += A[i][3];
printf("P%d\t%d\t%d\t%d\n", A[i][0], A[i][1], A[i][2], A[i][3]);
}
avg_tat = (float) total / n;

printf("\nAverage Waiting Time = %.2f", avg_wt);
printf("\nAverage Turnaround Time = %.2f\n", avg_tat);

return 0;
}
```

OUTPUT:



```
$ bash sjf.sh
Enter the number of processes: 2
Enter the burst time of the processes:
1
2
Process Burst Time Waiting Time Turn Around Time
1 1 0 1
2 2 1 3
```

RESULT:

Thus, the Program Shortest Job First is successfully implemented.

Ex. No: 6c

Date: 16/2/25

PRIORITY SCHEDULING

AIM:

To implement a priority scheduling technique

ALGORITHM:

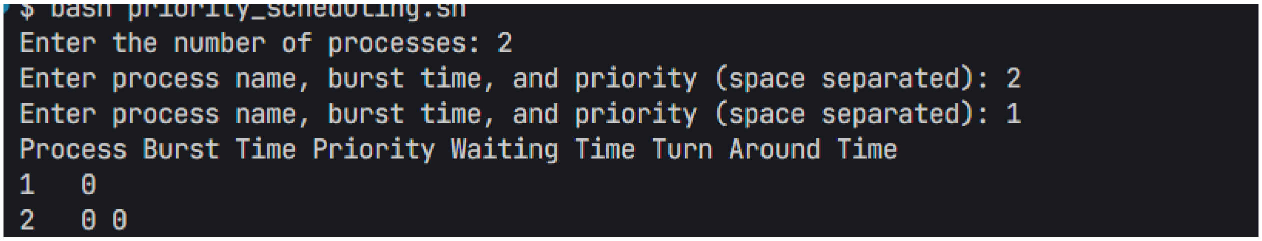
1. Get the number of processes from the user.
2. Read the process name, burst time and priority of the process.
3. Sort based on burst time of all processes in ascending order based on priority
4. Calculate the total waiting time and total turnaround time for each process
5. Display the process name & burst time for each process.
6. Display the total waiting time, average waiting time, turnaround time.

PROGRAM:

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

void swap(int *a, int *b) {
    int temp = *a;
    *a = *b;
    *b = temp;
}

int main() {
  int n;
  printf("Enter number of processes: ");
  scanf("%d", &n);

  int *burst = (int*)malloc(n * sizeof(int));
  int *priority = (int*)malloc(n * sizeof(int));
  int *pid = (int*)malloc(n * sizeof(int));
  int total_wait = 0, total_turnaround = 0;

  for (int i = 0; i < n; i++) {
      printf("Enter Burst Time and Priority for Process %d: ", i + 1);
      scanf("%d %d", &burst[i], &priority[i]);
      pid[i] = i + 1;
   }

    for (int i = 0; i < n - 1; i++) {
         for (int j = i + 1; j < n; j++) {
            if (priority[j] > priority[i]) {
                swap(&priority[i], &priority[j]);
                swap(&burst[i], &burst[j]);
                swap(&pid[i], &pid[j]);
            }
```

```
        }
    }
     int wait_time = 0;
     printf("\nProcess   Burst Time   Wait Time   Turnaround Time\n");

     for (int i = 0; i < n; i++) {
         int turnaround_time = wait_time + burst[i];
         total_wait += wait_time;
         total_turnaround += turnaround_time;

         printf("P%d        %d          %d          %d\n", pid[i], burst[i], wait_time, turnaround_time);

         wait_time += burst[i];
     }

     printf("\nAverage Waiting Time: %.2f\n", (float)total_wait / n);
     printf("Average Turnaround Time: %.2f\n", (float)total_turnaround / n);

     free(burst);
     free(priority);
     free(pid);

   return 0;
}
```

OUTPUT:



```
$ bash priority_scheduling.sh
Enter the number of processes: 2
Enter process name, burst time, and priority (space separated): 2
Enter process name, burst time, and priority (space separated): 1
Process Burst Time Priority Waiting Time Turn Around Time
1   0
2   0 0
```

RESULT:

Thus, the Program of Priority scheduling is successfully implemented.

Ex. No: 6d

Date: 16/2/25

ROUND ROBIN SCHEDULING

AIM:

To implement the round-robin (RR) scheduling technique

ALGORITHM:

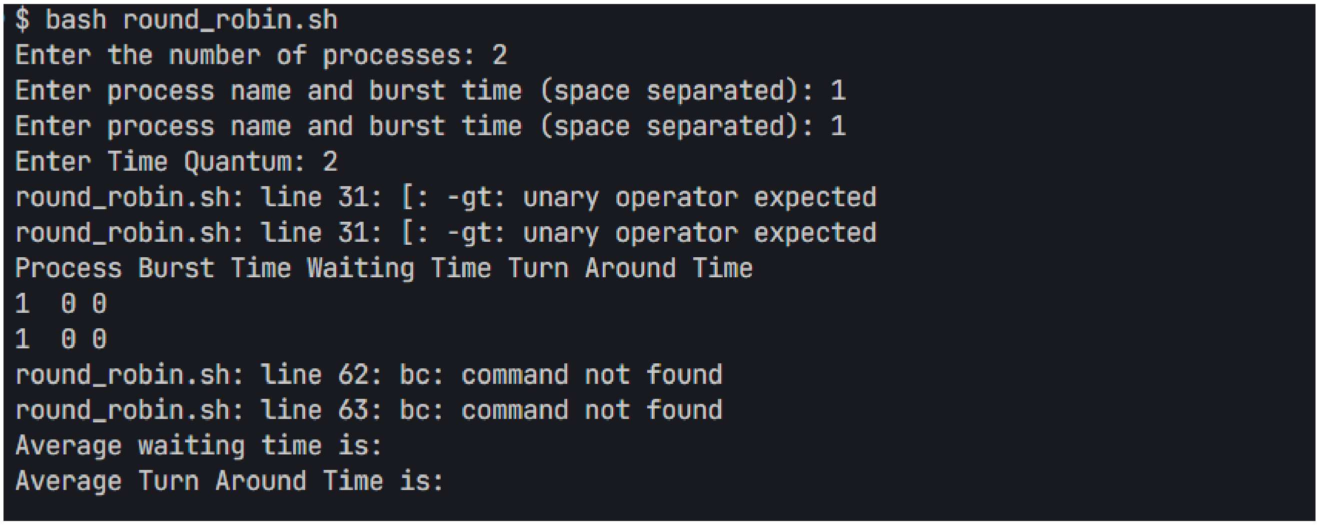
```
1. Declare the structure and its elements.
2. Get a number of processes and Time quantum as input from the user.
3. Read the process name, arrival time and burst time
4. Create an array rem_bt[] to keep track of the remaining burst time of processes which is initially copy of bt[] (burst times array)
5. Create another array wt[] to store waiting times of processes. Initialize this array as 0.
6. Initialize time : t = 0
7. Keep traversing all processes while all processes are not done. Do the following for i'th process if it is not done yet.
a- If rem_bt[i] > quantum
(i) t = t + quantum
(ii) bt_rem[i] -= quantum;
b- Else // Last cycle for this process
(i) t = t + bt_rem[i];
(ii) wt[i] = t - bt[i]
(iii) bt_rem[i] = 0; // This process is over
8. Calculate the waiting time and turnaround time for each process.
9. Calculate the average waiting time and average turnaround time.
10. Display the results.
```

PROGRAM:

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

int main() {
int n, time_quantum;
printf("Enter number of processes: ");
scanf("%d", &n);

int *arrival = (int*)malloc(n * sizeof(int));
int *burst = (int*)malloc(n * sizeof(int));
int *remaining = (int*)malloc(n * sizeof(int));
int wait_time = 0, turnaround_time = 0, total = 0, x = n;

for (int i = 0; i < n; i++) {
    printf("Enter arrival time and burst time for process %d: ", i + 1);
    scanf("%d %d", &arrival[i], &burst[i]);
```

```
       remaining[i] = burst[i];
   }
     printf("Enter time quantum: ");
     scanf("%d", &time_quantum);printf("\nProcess\tBurst\tTurnaround\tWaiting\n");

      for (int i = 0; x != 0;) {
         if (remaining[i] > 0) {
             if (remaining[i] <= time_quantum) {
                 total += remaining[i];
                 remaining[i] = 0;
                 x--;
                 printf("P%d\t%d\t%d\t\t%d\n", i + 1, burst[i], total - arrival[i], total - arrival[i] - burst[i]);
                 wait_time += total - arrival[i] - burst[i];
                 turnaround_time += total - arrival[i];
             } else {
                 remaining[i] -= time_quantum;
                 total += time_quantum;
             }
         }

         i = (i + 1) % n;
   }

       printf("\nAverage Waiting Time: %.2f", (float)wait_time / n);
       printf("\nAverage Turnaround Time: %.2f\n", (float)turnaround_time / n);

       free(arrival);
       free(burst);
       free(remaining);

       return 0;
}
```

OUTPUT:



```
$ bash round_robin.sh
Enter the number of processes: 2
Enter process name and burst time (space separated): 1
Enter process name and burst time (space separated): 1
Enter Time Quantum: 2
round_robin.sh: line 31: [: -gt: unary operator expected
round_robin.sh: line 31: [: -gt: unary operator expected
Process Burst Time Waiting Time Turn Around Time
1  0 0
1  0 0
round_robin.sh: line 62: bc: command not found
round_robin.sh: line 63: bc: command not found
Average waiting time is:
Average Turn Around Time is:
```

RESULT:

Thus, the Program of Round Robin Scheduling is successfully implemente

Ex. No: 7
Date: 22/2/25

IPC USING SHARED MEMORY

AIM:

To write a C program to do Inter-Process Communication (IPC) using shared memory between the sender process and the receiver process.

ALGORITHM:

sender

1. Set the size of the shared memory segment
2. Allocate the shared memory segment using shmget
3. Attach the shared memory segment using shmat
4. Write a string to the shared memory segment using sprintf
5. Set delay using sleep
6. Detach shared memory segment using shmdt

receiver

1. Set the size of the shared memory segment
2. Allocate the shared memory segment using shmget
3. Attach the shared memory segment using shmat
4. Print the shared memory contents sent by the sender process.
5. Detach shared memory segment using shmdt

PROGRAM:
SENDER

```
#include <stdio.h>
#include <stdlib.h>
#include <string.h>
#include <sys/ipc.h>
#include <sys/shm.h>
#include <unistd.h>

#define SHMSIZE 1024

typedef struct {
    int ready;
    char message[SHMSIZE];
} SharedMemory;
```

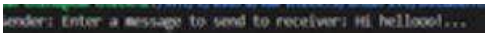
```
int main() {
    key_t key = ftok("sender.c", 65);
    int shmid;
    SharedMemory *shm;

    shmid = shmget(key, sizeof(SharedMemory), 0666 | IPC_CREAT);
    if (shmid == -1) {
        perror("shmget failed");
        exit(1);
    }

    shm = (SharedMemory *)shmat(shmid, NULL, 0);
    if (shm == (SharedMemory *)-1) {
        perror("shmat failed");
        exit(1);
    }

    printf("Sender: Enter a message to send to receiver: ");
    fgets(shm->message, SHMSIZE, stdin);

    shm->message[strcspn(shm->message, "\n")] = '\0';


    shm->ready = 1;

    sleep(5);

    if (shmdt(shm) == -1) {
        perror("shmdt failed");
        exit(1);
    }

    return 0;
}
```

RECEIVER

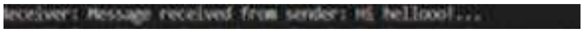
```
#include <stdio.h>
#include <stdlib.h>
#include <string.h>
#include <sys/ipc.h>
#include <sys/shm.h>
#include <unistd.h>

#define SHMSIZE 1024

typedef struct {
    int ready;
    char message[SHMSIZE];
} SharedMemory;
```

```
int main() {
    key_t key = ftok("sender.c", 65);
    int shmid;
    SharedMemory *shm;

    shmid = shmget(key, sizeof(SharedMemory), 0666 | IPC_CREAT);
    if (shmid == -1) {
        perror("shmget failed");
        exit(1);
    }

    shm = (SharedMemory *)shmat(shmid, NULL, 0);
    if (shm == (SharedMemory *)-1) {
        perror("shmat failed");
        exit(1);
    }


    while (shm->ready == 0) {
        sleep(1);
    }

    printf("Receiver: Message received from sender: %s\n", shm->message);

    if (shmdt(shm) == -1) {
        perror("shmdt failed");
        exit(1);
    }

    if (shmctl(shmid, IPC_RMID, NULL) == -1) {
        perror("shmctl failed");
        exit(1);
    }

    return 0;
}
```

OUTPUT:



```
Sender: Enter a message to send to receiver: Hi hellooo!...
```



```
Receiver: Message received from sender: Hi hellooo!...
```

RESULT:

Thus, the IPC Program with Shared Memory is Successfully Implemented.

Ex. No: 8
Date: 22/2/25

PRODUCER CONSUMER USING SEMAPHORES

AIM:
To write a program to implement solutions to producer consumer problem using semaphores.

ALGORITHM:

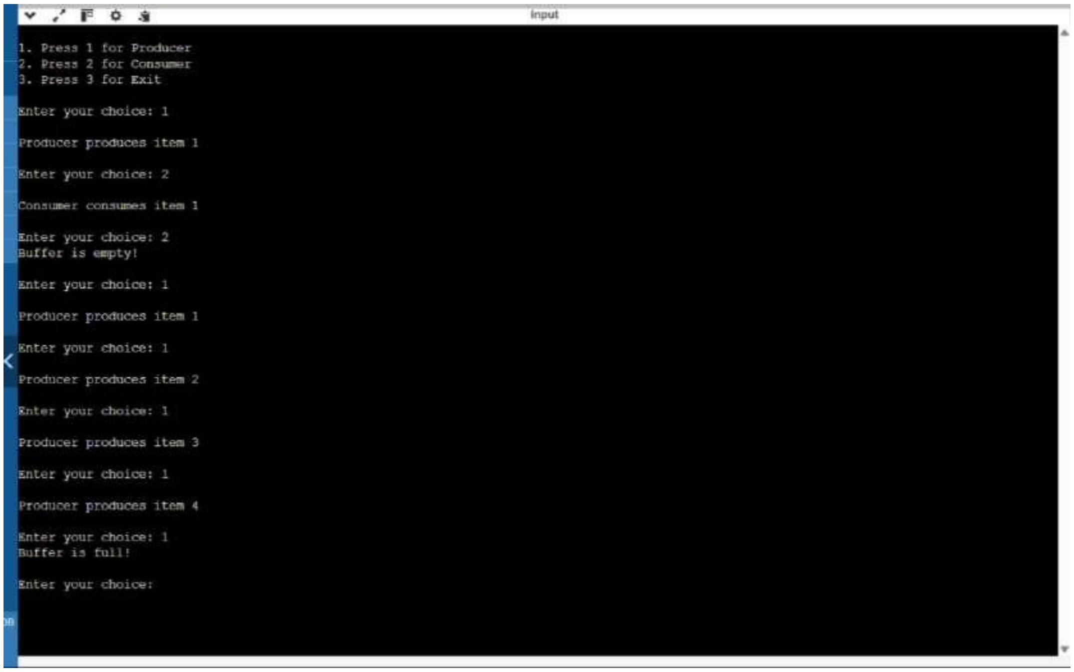
1. Initialize semaphore empty, full and mutex.
2. Create two threads- the producer thread and the consumer thread.
3. Wait for target thread termination.
4. Call sem_wait on empty semaphore followed by mutex semaphore before entry into critical section.
5. Produce/Consume the item in the critical section.
6. Call sem_post on mutex semaphore followed by full semaphore
7. before exiting the critical section.
8. Allow the other thread to enter its critical section.
9. Terminate after looping ten times in producer and consumer Threads each.

PROGRAM:

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

int mutex = 1;
int full = 0;
int empty = 10, x = 0;

pthread_mutex_t lock;

void *producer(void *arg)
{
    pthread_mutex_lock(&lock);

    if (empty != 0) {
        --mutex;
        ++full;
        --empty;
        x++;
        printf("\nProducer produces item %d\n", x);
        ++mutex;
    } else {
        printf("Buffer is full!\n");
    }

    pthread_mutex_unlock(&lock);
    return NULL;
```

```
}

void *consumer(void *arg)
{
    pthread_mutex_lock(&lock);

    if (full != 0) {
        --mutex;
        --full;
        ++empty;
        printf("\nConsumer consumes item %d\n", x);
        x--;
        ++mutex;
    } else {
        printf("Buffer is empty!\n");
    }

    pthread_mutex_unlock(&lock);
    return NULL;
}

int main()
{
    int n, i;
    pthread_t prod_thread, cons_thread;

    pthread_mutex_init(&lock, NULL);

    printf("\n1. Press 1 for Producer"
           "\n2. Press 2 for Consumer"
           "\n3. Press 3 for Exit\n");

    for (i = 1; i > 0; i++) {
        printf("\nEnter your choice: ");
        scanf("%d", &n);

        switch (n) {
        case 1:
            if (mutex == 1 && empty != 0) {
                pthread_create(&prod_thread, NULL, producer, NULL);
                pthread_join(prod_thread, NULL);
            } else {
                printf("Buffer is full!\n");
            }
            break;

        case 2:
            if (mutex == 1 && full != 0) {
                pthread_create(&cons_thread, NULL, consumer, NULL);
                pthread_join(cons_thread, NULL);
            } else {
                printf("Buffer is empty!\n");
            }
            break;

        case 3:
            pthread_mutex_destroy(&lock);
            exit(0);
            break;
        default:
            printf("Invalid choice! Please enter a valid option.\n");
        }
    }

    return 0;
}
```

OUTPUT:



```
1. Press 1 for Producer
2. Press 2 for Consumer
3. Press 3 for Exit

Enter your choice: 1

Producer produces item 1

Enter your choice: 2

Consumer consumes item 1

Enter your choice: 2
Buffer is empty!

Enter your choice: 1

Producer produces item 1

Enter your choice: 1

Producer produces item 2

Enter your choice: 1

Producer produces item 3

Enter your choice: 1

Producer produces item 4

Enter your choice: 1
Buffer is full!

Enter your choice:
```

RESULT:

Thus, the Producer Consumer Program using Semaphore is Successfully Implemented.

Ex. No.: 9
Date: 22/2/25

DEADLOCK AVOIDANCE

AIM:

To find out a safe sequence using Banker’s algorithm for deadlock avoidance.

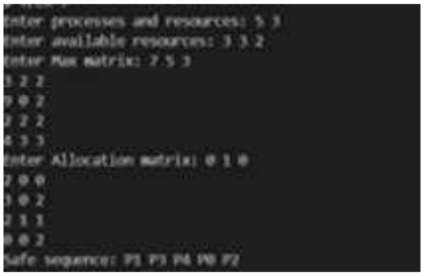
ALGORITHM:

1. Initialize work=available and finish[i]=false for all values of i
2. Find an i such that both:
finish[i]=false and Needi<= work
3. If no such i exists go to step 6
4. Compute work=work+allocationi
5. Assign finish[i] to true and go to step 2
6. If finish[i]==true for all i, then print safe sequence
7. Else print there is no safe sequence.

PROGRAM:

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

#define MAX 10

void findSafeSequence(int n, int m, int available[], int max[][MAX], int allocation[][MAX]) {
    int work[MAX], finish[MAX] = {0}, safeSeq[MAX], need[MAX][MAX];
    for (int i = 0; i < m; i++) work[i] = available[i];
    for (int i = 0; i < n; i++)
        for (int j = 0; j < m; j++)
            need[i][j] = max[i][j] - allocation[i][j];

    int count = 0;
    while (count < n) {
        bool found = false;
        for (int i = 0; i < n; i++) {
            if (!finish[i]) {
                bool canAllocate = true;
                for (int j = 0; j < m; j++)
                    if (need[i][j] > work[j]) { canAllocate = false; break; }
                if (canAllocate) {
                    for (int j = 0; j < m; j++) work[j] += allocation[i][j];
                    safeSeq[count++] = i;
                    finish[i] = 1;
                    found = true;
                }
            }
        }
        if (!found) { printf("No safe sequence.\n"); return; }
    }
    printf("Safe sequence: ");
    for (int i = 0; i < n; i++) printf("P%d ", safeSeq[i]);
    printf("\n");
}

int main() {
    int n, m, available[MAX], max[MAX][MAX], allocation[MAX][MAX];

    printf("Enter processes and resources: ");
    scanf("%d %d", &n, &m);
    while (getchar() != '\n');

    printf("Enter available resources: ");
    for (int i = 0; i < m; i++) scanf("%d", &available[i]);
    while (getchar() != '\n');

    printf("Enter Max matrix: \n");
    for (int i = 0; i < n; i++)
        for (int j = 0; j < m; j++) scanf("%d", &max[i][j]);
    while (getchar() != '\n');

    printf("Enter Allocation matrix: \n");
    for (int i = 0; i < n; i++)
        for (int j = 0; j < m; j++) scanf("%d", &allocation[i][j]);
    while (getchar() != '\n');

    findSafeSequence(n, m, available, max, allocation);
    return 0;
}
```

OUTPUT:



```
Enter processes and resources: 5 3
Enter available resources: 3 3 2
Enter Max matrix: 7 5 3
3 2 2
9 0 2
2 2 2
4 3 3
Enter Allocation matrix: 0 1 0
2 0 0
3 0 2
2 1 1
0 0 2
Safe sequence: P1 P3 P4 P0 P2
```

RESULT:

Thus, the Safe Sequence is found using Banker’s Algorithm for Deadlock Avoidance.

Ex. No: 10a
Date: 7/3/25

BEST FIT

AIM:

To implement Best Fit memory allocation technique using Python.

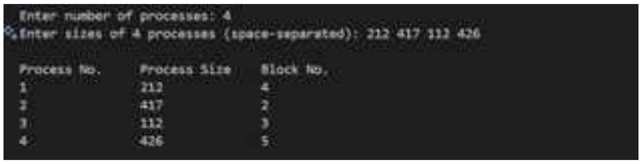
ALGORITHM:

1. Input memory blocks and processes with sizes
2. Initialize all memory blocks as free.
3. Start by picking each process and find the minimum block size that can be assigned to current process
4. If found then assign it to the current process.
5. If not found then leave that process and keep checking the further processes.

PROGRAM:

```
def best_fit(blocks, processes):
    allocation = [-1] * len(processes)

    for i in range(len(processes)):
        best_index = -1

        for j in range(len(blocks)):
            if blocks[j] >= processes[i]:
                if best_index == -1 or blocks[j] < blocks[best_index]:
                    best_index = j

        if best_index != -1:
            allocation[i] = best_index
            blocks[best_index] -= processes[i]

    print("\nProcess No.\tProcess Size\tBlock No.")
    for i in range(len(processes)):
        print(f"{i + 1}\t\t{processes[i]}\t\t{allocation[i] + 1 if allocation[i] != -1 else 'Not Allocated'}")

if __name__== "__main__":
    num_blocks = int(input("Enter number of memory blocks: "))
    blocks = list(map(int, input(f"Enter sizes of {num_blocks} memory blocks (space-separated): ").split()))

    num_processes = int(input("\nEnter number of processes: "))
    processes = list(map(int, input(f"Enter sizes of {num_processes} processes (space-separated): ").split()))

    best_fit(blocks, processes)
```

OUTPUT:



```
Enter number of processes: 4
Enter sizes of 4 processes (space-separated): 212 417 112 426

Process No.     Process Size    Block No.
1               212             4
2               417             2
3               112             3
4               426             5
```

RESULT:

Thus, the Best Fit Memory allocation technique is implemented successfully using Python.

Ex. No: 10b
Date: 7/3/25

FIRST FIT

AIM:

To write a C program for the implementation of memory allocation methods for a fixed partition using the first fit.

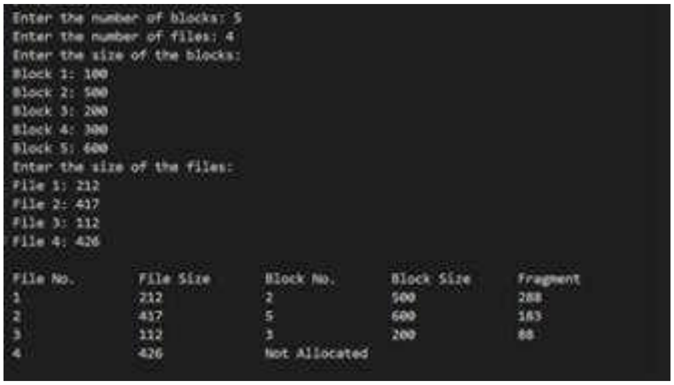
ALGORITHM:

1. Define the max as 25.
2. Declare the variable frag[max],b[max],f[max],i,j, nb,nf, temp, highest=0, bf[max],ff[max].
3. Get the number of blocks, files, size of the blocks using a for loop.
4. In for loop check bf[j]!=1, if so temp=b[j]-f[i]
5. Check the highest.

PROGRAM:

```
#include <stdio.h>

#define MAX 25

int main() {
    int frag[MAX], b[MAX], f[MAX], i, j, nb, nf, temp;
    static int bf[MAX], ff[MAX];

    // Input number of blocks
    printf("Enter the number of blocks: ");
    scanf("%d", &nb);

    // Input number of files
    printf("Enter the number of files: ");
    scanf("%d", &nf);

    // Input sizes of blocks
    printf("Enter the size of the blocks:\n");
    for (i = 0; i < nb; i++) {
        printf("Block %d: ", i + 1);
        scanf("%d", &b[i]);
    }

    // Input sizes of files
    printf("Enter the size of the files:\n");
    for (i = 0; i < nf; i++) {
        printf("File %d: ", i + 1);
        scanf("%d", &f[i]);
    }
    // First Fit Allocation
    for (i = 0; i < nf; i++) {
        for (j = 0; j < nb; j++) {
            if (bf[j] != 1) {  // If block is not allocated
                temp = b[j] - f[i];
                if (temp >= 0) { // If block can accommodate file
                    ff[i] = j;       // Allocate block j to file i
                    bf[j] = 1;       // Mark block as allocated
                    frag[i] = temp;  // Calculate fragmentation
                    break;
                }
            }
        }
    }

    // Output allocation result
    printf("\nFile No.\tFile Size\tBlock No.\tBlock Size\tFragment\n");
    for (i = 0; i < nf; i++) {
        if (bf[ff[i]] == 1)
            printf("%d\t\t%d\t\t%d\t\t%d\t\t%d\n", i + 1, f[i], ff[i] + 1, b[ff[i]], frag[i]);
        else
            printf("%d\t\t%d\t\tNot Allocated\n", i + 1, f[i]);
    }

    return 0;
}
```

OUTPUT:



```
Enter the number of blocks: 5
Enter the number of files: 4
Enter the size of the blocks:
Block 1: 100
Block 2: 500
Block 3: 200
Block 4: 300
Block 5: 600
Enter the size of the files:
File 1: 212
File 2: 417
File 3: 112
File 4: 426

File No.        File Size       Block No.       Block Size      Fragment
1               212             2               500             288
2               417             5               600             183
3               112             3               200             88
4               426             Not Allocated
```

RESULT:

Thus, the First Fit allocation technique is implemented successfully using C

Ex. No: 11a
Date: 21/3/25

FIFO PAGE REPLACEMENT

AIM:

To find out the number of page faults that occur using the First-in First-out (FIFO) page replacement technique.

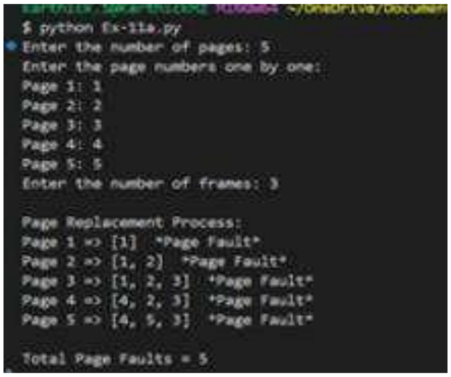
ALGORITHM:

1. Declare the size with respect to page length
2. Check the need for replacement from the page to memory
3. Check the need for replacement from the old page to the new page in memory
4. Form a queue to hold all pages
5. Insert the page required memory into the queue
6. Check for bad replacement and page fault
7. Get the number of processes to be inserted
8. Display the values.

PROGRAM:

```
def fifo_page_replacement(pages,
    frame_size): frames = []
    page_faults = 0
    front = 0

    print("\nPage

    Replacement Process:")

    for page in pages:
        if page not in frames:
            if len(frames) <
                frame_size:
                frames.append(page)
            else:
                frames[front] = page
                front = (front + 1) %
            frame_size
            page_faults += 1
            print(f"Page {page} => {frames}
        *Page Fault*") else:
            print(f"Page {page} =>

    {frames}") print(f"\nTotal Page Faults
    = {page_faults}")

if __name___== "__main__":
    n = int(input("Enter the number
    of pages: ")) pages = []
    print("Enter the page numbers
    one by one:") for i in range(n):
        page = int(input(f"Page
        {i+1}: "))
        pages.append(page)
    frame_size = int(input("Enter the number

    of frames: "))

    fifo_page_replacement(pages, frame_size)
```

OUTPUT:



```
[illegible] ~/OneDrive/Documen
$ python Ex-11a.py
Enter the number of pages: 5
Enter the page numbers one by one:
Page 1: 1
Page 2: 2
Page 3: 3
Page 4: 4
Page 5: 5
Enter the number of frames: 3

Page Replacement Process:
Page 1 => [1]  *Page Fault*
Page 2 => [1, 2]  *Page Fault*
Page 3 => [1, 2, 3]  *Page Fault*
Page 4 => [4, 2, 3]  *Page Fault*
Page 5 => [4, 5, 3]  *Page Fault*

Total Page Faults = 5
```

RESULT:

Thus, the FIFO Page Replacement is Successfully Implemented using Python.

Ex. No: 11b
Date: 25/3/25

LRU

AIM:

To write a C program to implement LRU page replacement algorithm.

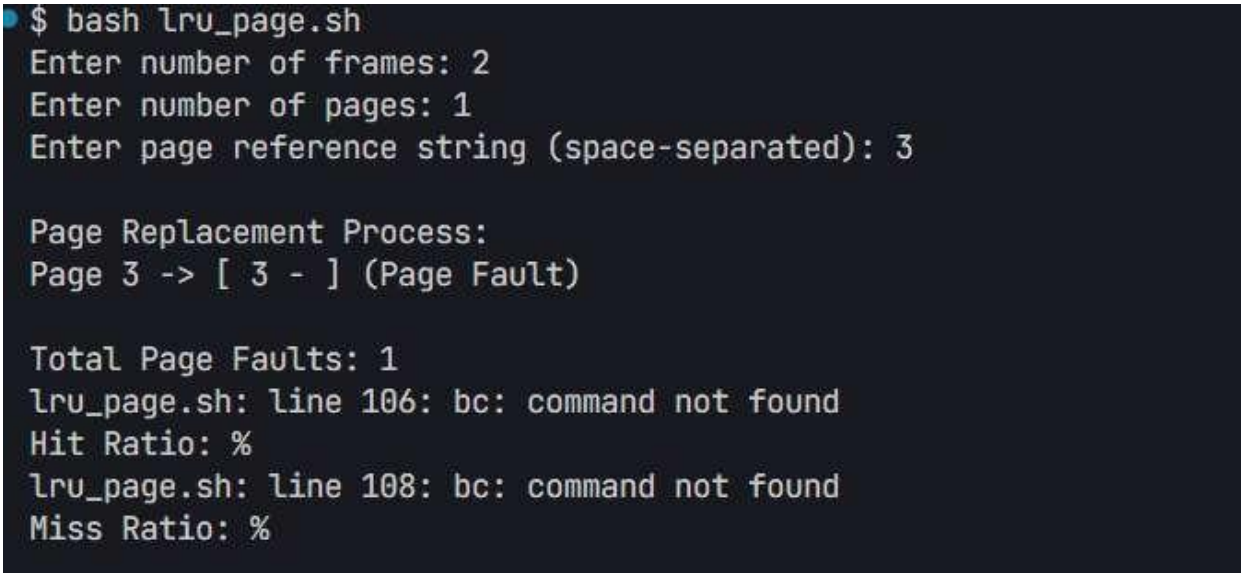
ALGORITHM:

1. Start the process
2. Declare the size
3. Get the number of pages to be inserted
4. Get the value
5. Declare counter and stack
6. Select the least recently used page by counter value
7. Stack them according the selection.
8. Display the values
9. Stop the process

PROGRAM:

```
#include <stdio.h>

int main() {
    int pages[50], frames[10], counter[10];
    int n, frameSize, i, j, k, flag, time = 0, faults = 0;

    printf("Enter the number of frames: ");
    scanf("%d", &frameSize);

    printf("Enter the number of pages: ");
    scanf("%d", &n);

    printf("Enter the page reference string: ");
    for (i = 0; i < n; i++) {
        scanf("%d", &pages[i]);
    }

    for (i = 0; i < frameSize; i++) {
        frames[i] = -1;      // Empty frames
        counter[i] = 0;      // Last used time
    }

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

        // Check if page is already in a frame
        for (j = 0; j < frameSize; j++) {
            if (frames[j] == pages[i]) {
                counter[j] = ++time;  // Update last used time
                flag = 1;
                break;
            }
        }

        // Page not found, replace using LRU
        if (flag == 0) {
            int pos = -1, min = 9999;

            // Find least recently used frame or empty one
            for (j = 0; j < frameSize; j++) {
                if (frames[j] == -1) {
                    pos = j;
                    break;
                } else if (counter[j] < min) {
                    min = counter[j];
                    pos = j;
                }
            }

            frames[pos] = pages[i];
            counter[pos] = ++time;
            faults++;
        }

        // Print current frame status
        printf("Frames after inserting %d: ", pages[i]);
        for (k = 0; k < frameSize; k++) {
            if (frames[k] != -1)
                printf("%d ", frames[k]);
            else
                printf("- ");
        }
        printf("\n");
    }

    printf("\nTotal Page Faults: %d\n", faults);
    return 0;
}
```

OUTPUT:



```
$ bash lru_page.sh
Enter number of frames: 2
Enter number of pages: 1
Enter page reference string (space-separated): 3

Page Replacement Process:
Page 3 -> [ 3 - ] (Page Fault)

Total Page Faults: 1
lru_page.sh: line 106: bc: command not found
Hit Ratio: %
lru_page.sh: line 108: bc: command not found
Miss Ratio: %
```

RESULT:

Thus, the LRU Program is Successfully Implemented using C.

Ex. No: 11c
Date: 25/3/25

Optimal

AIM:

To write a c program to implement the Optimal page replacement algorithm

ALGORITHM:

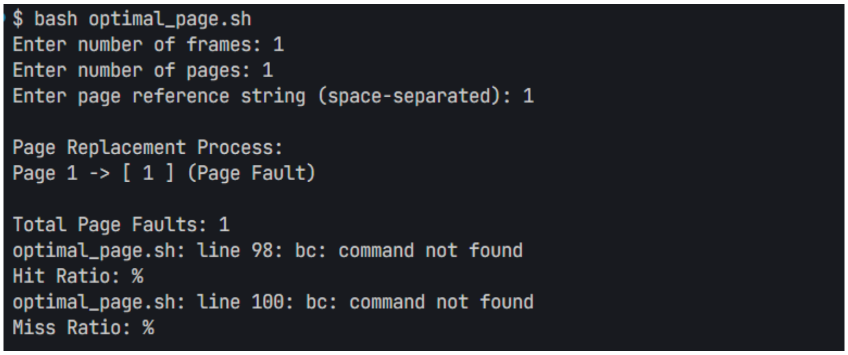
1. Start the process
2. Declare the size
3. Get the number of pages to be inserted
4. Get the value
5. Declare counter and stack
6. Select the least frequently used page by counter value.
7. Stack them according the selection.
8. Display the values
9. Stop the process

PROGRAM:

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

int isInFrame(int frame[], int count, int page) {
    for (int i = 0; i < count; i++)
        if (frame[i] == page) return 1;
    return 0;
}

int predict(int pages[], int frame[], int n, int index, int count) {
    int farthest = index, res = -1;
    for (int i = 0; i < count; i++) {
        int j;
        for (j = index; j < n; j++) {
            if (frame[i] == pages[j]) {
                if (j > farthest) {
                    farthest = j;
                    res = i;
                }
                break;
            }
        }
        if (j == n) return i;  // If page not found in future
    }
    return (res == -1) ? 0 : res;
}

int main() {
    int n, frameCount, pageFaults = 0, filled = 0;
```

```
printf("Enter number of pages: ");
scanf("%d", &n);
int* pages = malloc(n * sizeof(int));

printf("Enter the page numbers:\n");
for (int i = 0; i < n; i++)
    scanf("%d", &pages[i]);

printf("Enter number of frames: ");
scanf("%d", &frameCount);
int* frame = malloc(frameCount * sizeof(int));
for (int i = 0; i < frameCount; i++)
    frame[i] = -1;

for (int i = 0; i < n; i++) {
    if (!isInFrame(frame, frameCount, pages[i])) {
        if (filled < frameCount)
            frame[filled++] = pages[i];
        else
            frame[predict(pages, frame, n, i, frameCount)] = pages[i];
        pageFaults++;
    }

    printf("Frame: ");
    for (int j = 0; j < frameCount; j++)
        frame[j] == -1 ? printf("- ") : printf("%d ", frame[j]);
    printf("\n");
}

printf("\nTotal Page Faults = %d\n", pageFaults);
free(pages);
free(frame);
return 0;
```

OUTPUT:



```
$ bash optimal_page.sh
Enter number of frames: 1
Enter number of pages: 1
Enter page reference string (space-separated): 1

Page Replacement Process:
Page 1 -> [ 1 ] (Page Fault)

Total Page Faults: 1
optimal_page.sh: line 98: bc: command not found
Hit Ratio: %
optimal_page.sh: line 100: bc: command not found
Miss Ratio: %
```

RESULT:

Thus, the Optimal page replacement Program is Successfully Implemented using C.

Ex. No: 12
Date: 1/4/25

File Organization Technique- Single- and Two-level directory

AIM:

To implement File Organization Structures in C are

a. Single Level Directory

b. Two-Level Directory

c. Hierarchical Directory Structure

d. Directed Acyclic Graph Structure

A. SINGLE LEVEL DIRECTORY

ALGORITHM:

1. Start

2. Declare the number, names and size of the directories and file names. 3. Get the values for the declared variables.

4. Display the files that are available in the directories.

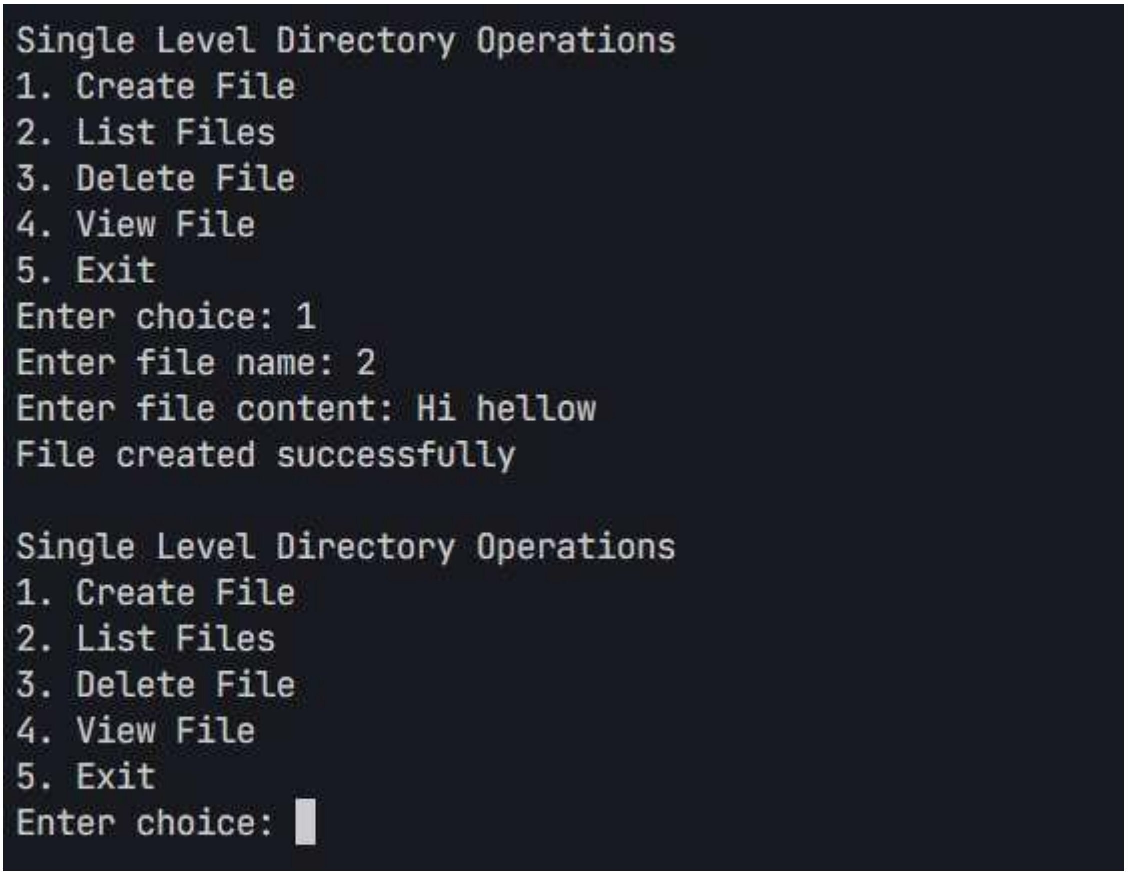
5. Stop.

PROGRAM:

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

struct File {
    char name[20];
};

int main() {
    int n, i;
    struct File files[10];

    printf("Enter the number of files: ");
    scanf("%d", &n);

    if (n <= 0 || n > 10) {
        printf("Please enter a valid number of files (1–10).\n");
        return 1;
    }

    for (i = 0; i < n; i++) {
        printf("Enter the file %d: ", i + 1);
```

```
            scanf("%s", files[i].name);
        }

        printf("\n\nRoot Directory\n");
        printf("|\n");

        for (i = 0; i < n; i++) {
            printf("|-- %s\n", files[i].name);
        }

        return 0;
    }
```

OUTPUT:



```
Single Level Directory Operations
1. Create File
2. List Files
3. Delete File
4. View File
5. Exit
Enter choice: 1
Enter file name: 2
Enter file content: Hi hellow
File created successfully

Single Level Directory Operations
1. Create File
2. List Files
3. Delete File
4. View File
5. Exit
Enter choice: 
```

B. TWO-LEVEL DIRECTORY STRUCTURE

ALGORITHM:

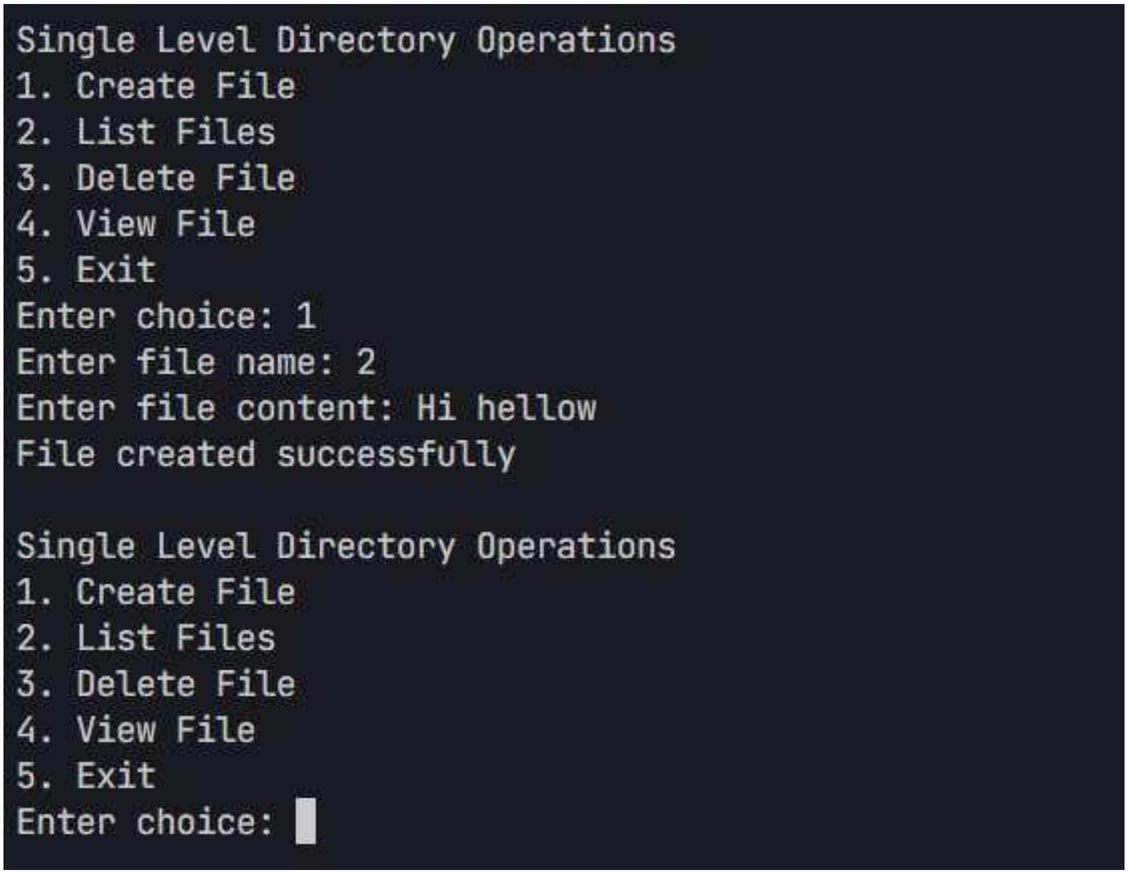
1. Start
2. Declare the number, names and size of the directories and subdirectories and file names.
3. Get the values for the declared variables.
4. Display the files that are available in the directories and subdirectories. 5. Stop.

PROGRAM:

```
#include <stdio.h>
    Implemented using C.
 #include <string.h>

 struct File {
     char name[20];
 };

 struct SubDirectory {
     char name[20];
     struct File files[10];
     int fileCount;
 };

 struct Directory {
     char name[20];
     struct SubDirectory subDirs[10];
     int subDirCount;
 };

 int main() {
     struct Directory dir;
     int i, j;

     printf("Enter root directory name: ");
     scanf("%s", dir.name);

     printf("How many subdirectories in '%s'? ", dir.name);
     scanf("%d", &dir.subDirCount);

     for (i = 0; i < dir.subDirCount; i++) {
         printf("\nEnter name of subdirectory %d under '%s': ", i + 1, dir.name);
         scanf("%s", dir.subDirs[i].name);

         printf("How many files in '%s'? ", dir.subDirs[i].name);
         scanf("%d", &dir.subDirs[i].fileCount);

         for (j = 0; j < dir.subDirs[i].fileCount; j++) {
             printf("Enter file %d in '%s': ", j + 1, dir.subDirs[i].name);
             scanf("%s", dir.subDirs[i].files[j].name);
         }
     }


     printf("\nDirectory Structure:\n");
     printf("NULL\n");
     printf("|__%s\n", dir.name);

     for (i = 0; i < dir.subDirCount; i++) {
         printf("    |__%s\n", dir.subDirs[i].name);
         for (j = 0; j < dir.subDirs[i].fileCount; j++) {
             printf("        |__%s\n", dir.subDirs[i].files[j].name);
```

```
        }
    }

    return 0;
}
```

OUTPUT:



```
Single Level Directory Operations
1. Create File
2. List Files
3. Delete File
4. View File
5. Exit
Enter choice: 1
Enter file name: 2
Enter file content: Hi hellow
File created successfully

Single Level Directory Operations
1. Create File
2. List Files
3. Delete File
4. View File
5. Exit
Enter choice: 
```

RESULT:

The File Organization Technique-Single and Two-Level Directory Program is Successfully Implemented using C.