Practical 1

Aim:	Installation of Operating System.
Questionnaires:	**1. List out the various ways to install operating system and explain them** **Ans :** ● DVD/CD Installation ● USB Installation ● Network Installation ● Pre-Installed Image ● Online/Cloud Installation ● Dual Boot Installation ● Upgrade Installation **2. From given ways which one is better to use for specific applications.** **Ans :** ● DVD/CD Installation: This method is useful when you have an OS installation disc and a computer with an optical drive ● USB Installation: This method is versatile and widely used because most computers have USB ports. ● Network Installation: Network installations are beneficial in enterprise environments or scenarios where you need to deploy OSs to multiple machines simultaneously. ● Pre-Installed Image: Pre-installed images are convenient when purchasing a new computer or when an OS comes bundled with specific hardware. ● Online/Cloud Installation: Online installations are useful when you want to quickly provision virtual machines or use cloud-based services. ● Dual Boot Installation: Dual booting is ideal if you need to run multiple operating systems on the same computer. ● Upgrade Installation: Upgrade installations are suitable when you want to update your existing OS to a newer version.

3. Which operating system is used for various tasks and applications ? Mention when to use which operating system with its advantages and disadvantages

Ans :

Here are some popular operating systems and their common use cases:

1. Windows:
   - Use Windows when: You require broad software compatibility, gaming, business productivity, or specific applications that are primarily available on Windows.
   - Advantages: Windows has a vast software library, extensive hardware support, and a user-friendly interface. It's widely used in the business world and offers compatibility with a wide range of applications and devices.
   - Disadvantages: Windows can be susceptible to malware and viruses, and its performance may degrade over time. It's also a proprietary OS, which means you may have limited control over certain aspects of the system.

2. macOS:
   - Use macOS when: You are working with creative applications, require a seamless integration with other Apple devices, or prefer a UNIX-based environment with a polished user interface.
   - Advantages: macOS offers a sleek and intuitive user experience, excellent integration with Apple hardware and devices, and is favored by professionals in creative industries. It provides a robust UNIX foundation and strong security features.
   - Disadvantages: macOS is limited to Apple hardware, which can be more expensive compared to other options. Software compatibility may be limited in certain areas, and gaming options are relatively smaller compared to Windows.

3. Linux:

- Use Linux when: You require a highly customizable and flexible OS, prefer open-source software, or need a stable and secure platform for development, servers, or specialized applications.
- Advantages: Linux is highly customizable, secure, and stable. It offers a wide variety of distributions (such as Ubuntu, Fedora, and CentOS) tailored for different use cases. It excels in server environments and is the preferred choice for developers and enthusiasts. Additionally, Linux distributions are often free to use.
- Disadvantages: Linux can have a steeper learning curve for beginners, and some hardware may have limited driver support. It may also require manual configuration and troubleshooting. Software availability can vary, and certain specialized applications may be designed for Windows or macOS.

4. Chrome OS:
- Use Chrome OS when: You primarily use web-based applications, require a simple and affordable option for basic computing tasks, or prefer a lightweight and secure OS.
- Advantages: Chrome OS offers fast boot times, seamless integration with Google services, automatic updates, and strong security. It's designed around web applications and is often found in Chromebooks, which are affordable and portable.
- Disadvantages: Chrome OS heavily relies on internet connectivity and web applications, which may limit functionality when offline. It may have limited support for specialized software or tasks that require high-performance hardware.

4. Compare virtual machine vmware and hyper v. Based on comparison list out specific usage for both

Ans :

VMware and Hyper-V are both popular virtualization platforms used for creating and managing virtual

machines (VMs) on host systems. Here's a comparison of the two:

Manufacturer:

VMware: Developed by VMware, a subsidiary of Dell Technologies.
Hyper-V: Developed by Microsoft as a component of Windows Server and Windows client operating systems.
Host OS Compatibility:

VMware: Supports a wide range of host operating systems, including Windows, Linux, and macOS.
Hyper-V: Primarily designed for Windows-based hosts, such as Windows Server and Windows 10 Pro/Enterprise.
Licensing:

VMware: Requires separate licenses for VMware vSphere and additional features like vCenter Server for advanced management.
Hyper-V: Included as a free feature in Windows Server editions and Windows 10 Pro/Enterprise.

5. List out the application for each way of installation of os.

Ans :

Here are some common applications for each method of operating system installation:

1. DVD/CD Installation:
   - Installing Windows 10 from a retail DVD or CD.
   - Installing Linux distributions like Ubuntu or Fedora from installation discs.
   - Installing macOS from a macOS installation DVD.

2. USB Installation:

	- Creating a bootable USB drive to install Windows 10, Linux distributions, or macOS. - Installing lightweight Linux distributions like Puppy Linux or Lubuntu on older computers without DVD drives. - Creating a Windows To Go USB drive for portable Windows installations. 3. Network Installation: - Enterprise-level deployments of Windows Server or Linux server distributions using network-based installation tools like Windows Deployment Services (WDS) or Preboot Execution Environment (PXE). - Installing Linux distributions like CentOS or Debian via network boot and installation servers. - Automated OS installations in data centers or large-scale computing environments. 4. Pre-Installed Image: - Purchasing a new laptop or desktop computer with Windows, macOS, or Linux pre-installed by the manufacturer. - Acquiring pre-installed images of virtual machines from cloud service providers like Amazon Web Services (AWS) or Microsoft Azure. 5. Online/Cloud Installation: - Creating virtual machines with specific operating systems in cloud platforms like AWS, Azure, or Google Cloud Platform (GCP). - Provisioning cloud-based instances with pre-configured OS images, such as Ubuntu Server or Windows Server. - Deploying containerized applications with predefined OS images using platforms like Docker or Kubernetes. 6. Dual Boot Installation: - Installing multiple operating systems on a computer to choose between them during startup.

- Setting up a dual boot configuration with Windows and Linux distributions like Ubuntu or Fedora.
- Dual booting macOS and Windows on an Apple computer using Boot Camp.

7. Upgrade Installation:
- Upgrading an existing Windows installation to a newer version, such as upgrading from Windows 7 to Windows 10.
- Updating macOS to the latest version available via the Mac App Store.
- Applying updates and patches to Linux distributions using package managers like apt, yum, or dnf.

6. How we can convert windows terminal to linux command prompt

Ans

To convert the Windows Terminal into a Linux terminal-like experience, we can follow these steps:

1. Install Windows Subsystem for Linux (WSL):
- Open PowerShell or Command Prompt as an administrator.
- Run the command `wsl --install` to enable WSL and install the necessary components.

2. Install a Linux distribution:
- Open the Microsoft Store.
- Search for a Linux distribution of your choice, such as Ubuntu, Debian, or Fedora.
- Select the desired Linux distribution and click "Install" to download and install it.

3. Launch the Linux distribution:
- Open the Windows Terminal application.
- Click on the "+" button in the tab bar to open a new terminal tab.

- In the drop-down menu, select the installed Linux distribution to start a new terminal session with that distribution.

4. Customize the Windows Terminal:
- Open the Windows Terminal application.
- Click on the downward arrow icon in the title bar and select "Settings" to open the settings.json file.
- Customize the settings to modify the appearance, behavior, and key bindings to match your preferences. For example, you can change the color scheme, font, or shortcut keys.

5. Install Linux terminal applications:
- Once you have your Linux distribution running in the Windows Terminal, you can install and use Linux terminal applications just like you would on a native Linux system.

7. Why to use virtualization

Ans:

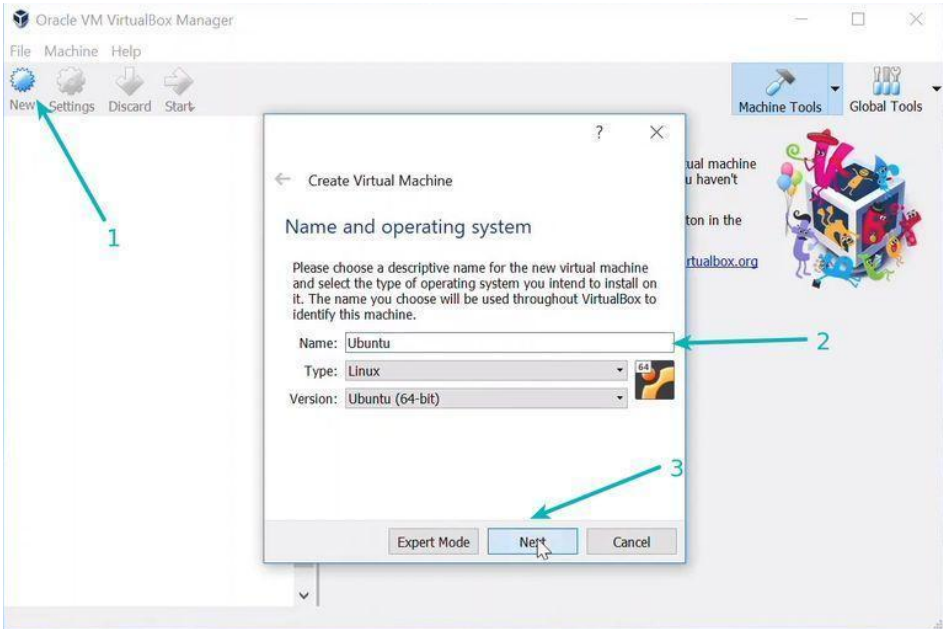
Virtualization offers several benefits and use cases that make it a valuable technology in various scenarios. Here are some reasons why virtualization is widely used:

1. Server Consolidation: Virtualization allows you to run multiple virtual machines (VMs) on a single physical server. This consolidation reduces hardware requirements, saves space, and lowers power consumption. It maximizes the utilization of server resources and reduces overall infrastructure costs.

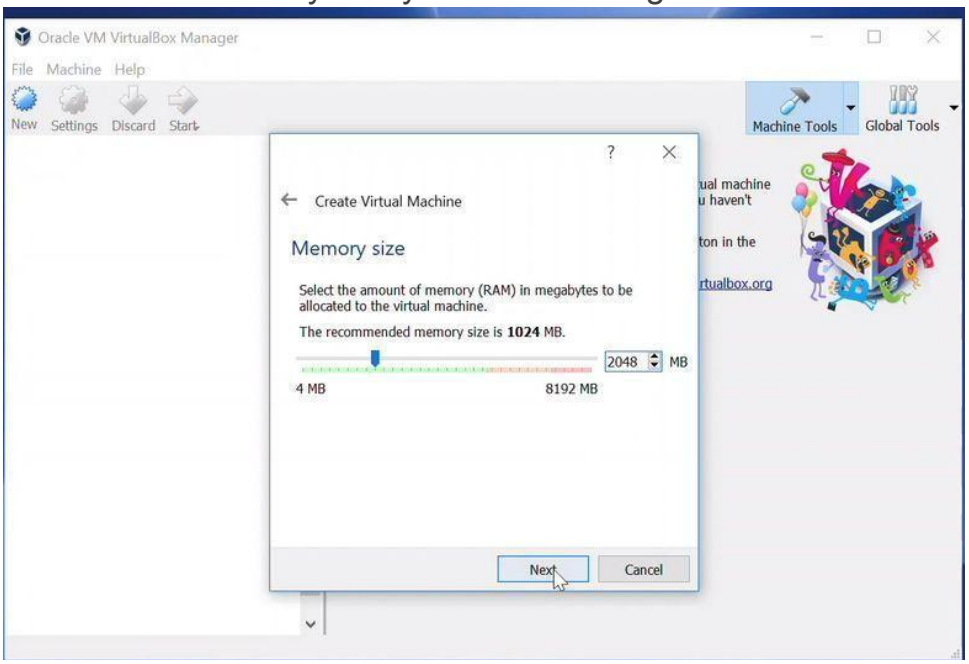
2. Resource Optimization: Virtualization enables efficient allocation and management of computing resources. By dynamically adjusting resource allocations to VMs based on demand, you can optimize CPU, memory, storage, and network utilization. This flexibility allows for better scalability, performance, and overall resource efficiency.

	3. Isolation and Security: Virtualization provides strong isolation between VMs, allowing each VM to operate independently and securely. This isolation helps prevent the spread of malware and improves overall system security. If one VM is compromised, it does not affect the others. 4. Testing and Development: Virtualization is widely used in software development and testing environments. Developers can create VMs to simulate different operating systems, network configurations, or software environments. It enables efficient testing, debugging, and compatibility checking without impacting the production environment. 5. Disaster Recovery and High Availability: Virtualization facilitates robust disaster recovery and high availability solutions. VMs can be easily replicated or migrated to another physical server or data center in case of hardware failures or emergencies. This capability ensures business continuity and minimizes downtime. 6. Scalability and Flexibility: Virtualization allows for quick and easy scaling of resources to meet changing needs. You can add or remove VMs as required without significant hardware changes. It provides the flexibility to adapt to workload fluctuations and accommodate business growth. 7. Legacy System Support: Virtualization enables the hosting of legacy applications and operating systems that may require outdated hardware or software dependencies. By virtualizing these systems, you can extend their lifespan and maintain compatibility while transitioning to newer hardware and software infrastructure.

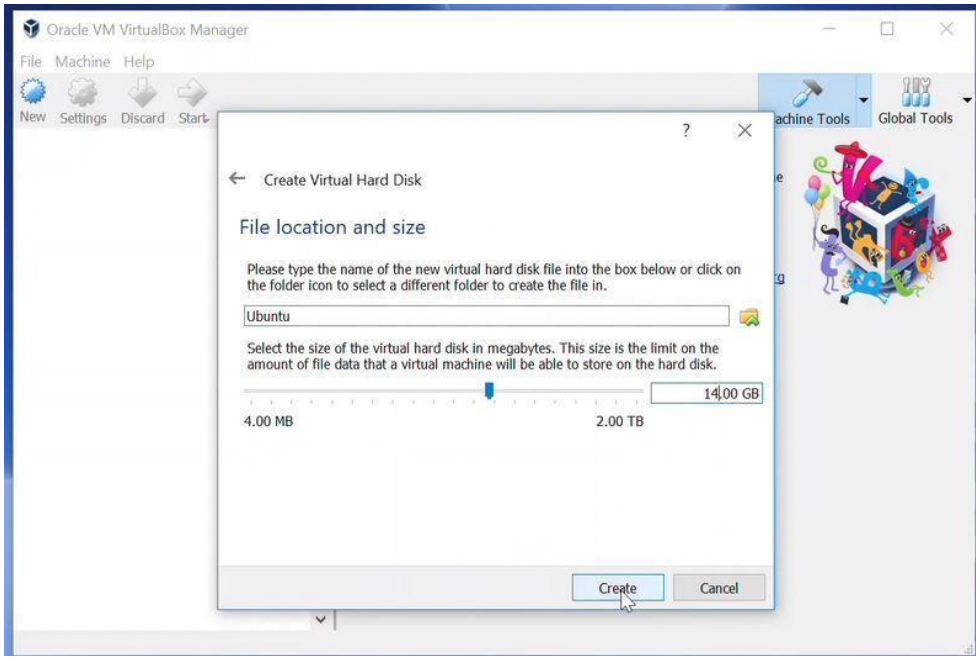
	8. Cloud Computing: Virtualization is a fundamental technology underlying cloud computing. Cloud service providers use virtualization to create and manage virtualized resources, providing customers with scalable, on-demand computing environments. Users can deploy and manage their VMs easily in the cloud.
Installation: (Steps , SS)	
	Step 1: Download and install VirtualBox **https://www.virtualbox.org/wiki/Downloads** **Step 2: Download the Linux ISO** **https://ubuntu.com/download/desktop** **Step 3: Install Linux using VirtualBox** ● Start VirtualBox, and click on the New symbol. Give the virtual OS a relevant name.



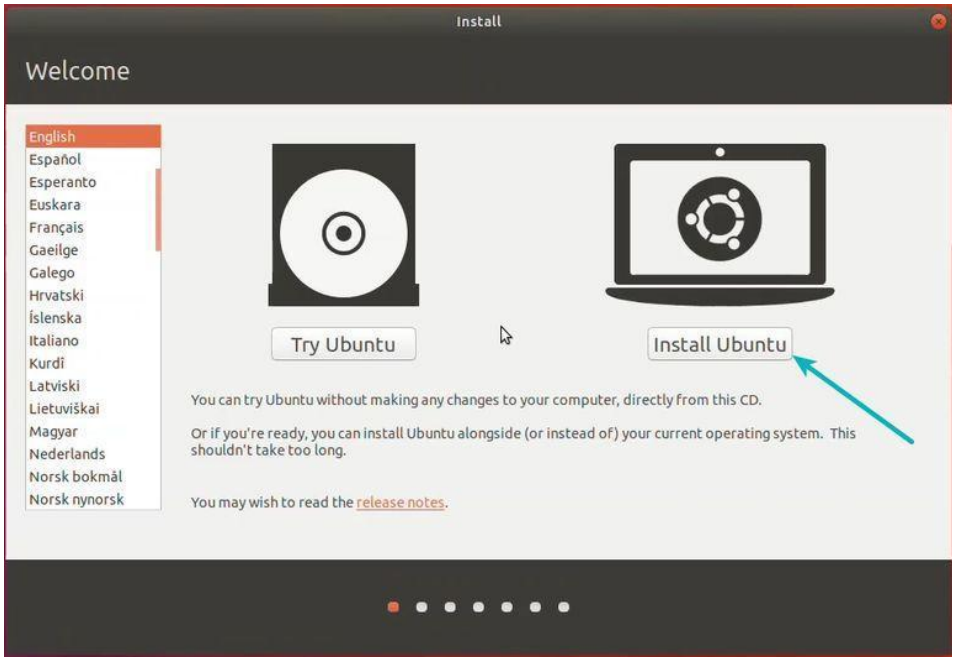
- Allocate RAM to the virtual OS. My system has 8GB of RAM and I decided to allocate 2GB of it. You can use more RAM if your system has enough extra.



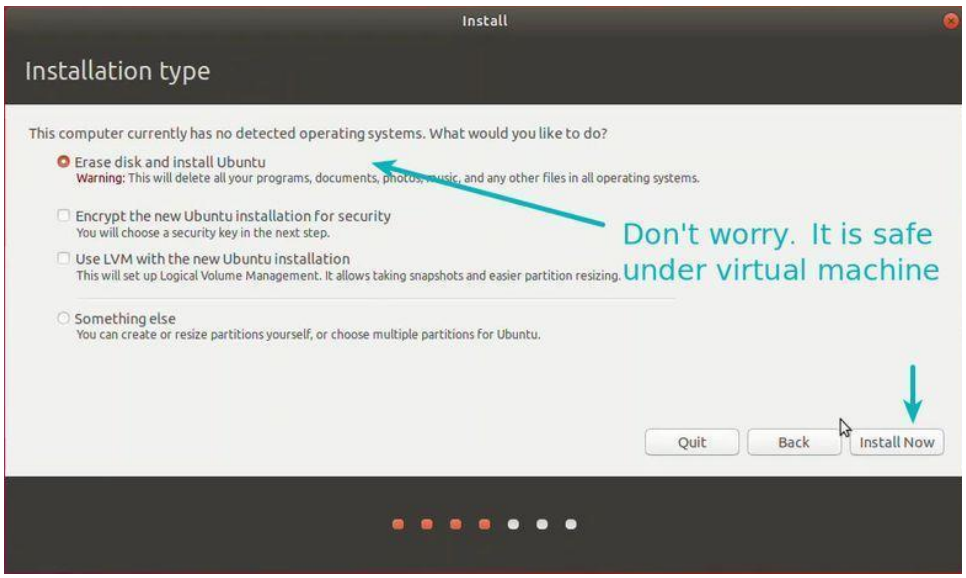
- Create a virtual disk. This serves as the hard disk of the virtual Linux system. It is where the virtual system will store its files.



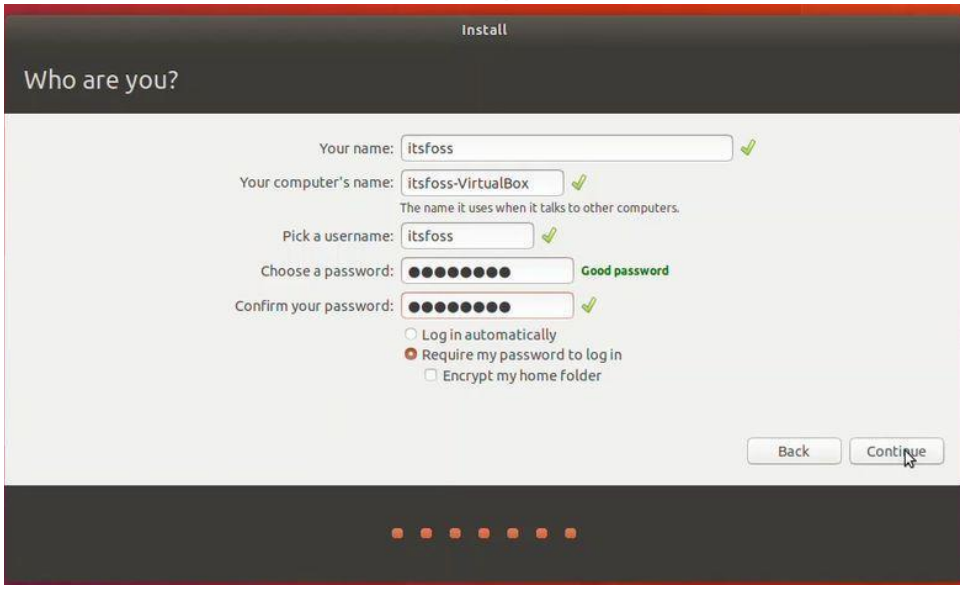
Start the created virtual machine . Following screen will appear. Select the Language and Click On **Install Ubuntu**



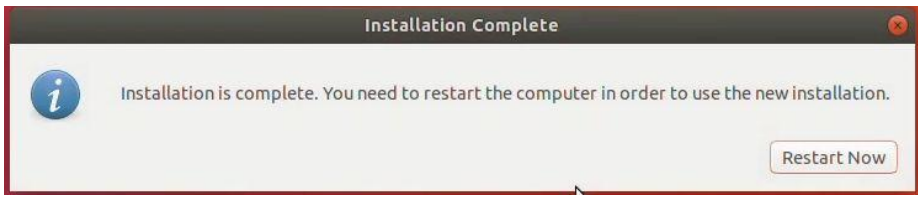
- Select ‘Erase disk and install Ubuntu’. Don’t worry. It won’t delete anything on your Windows operating system. You are using the virtual disk space of 15-20GB that we created in previous steps. It won’t impact the real operating system.



- Set User Credentials and password



- Restart the Machine and Ubuntu is installed successfully.



Conclusion:	From this practical , we learnt that how to install Ubuntu Operating System also I learnt hardware specifications required for various

	Operating System.

Practical 2

Aim	Introduction to OS and shell. 1. Access the command Line 2. Manage files and directories from command line 3. Create, edit and and view text files
Exercise Question	Exercise - 0 Enter these commands at the UNIX prompt, and try to interpret the output. 1. Passwd 2. Date 3. Hostname 4. Arch 5. uname –a 6. whoami 7. who 8. id 9. echo $SHELL 10. echo {con,pre}{sent,fer}{s,ed} 11. man ls (you may need to press q to quit) 12. man who (you may need to press q to quit) 13. clear 14. cal 2000 15. cal 9 1752 (do you notice anything unusual?) 16. bc -l (type quit or press Ctrl-d to quit) 17. echo 5+4 | bc –l 18. yes please (you may need to press Ctrl-c to quit) 19. time sleep 5

20. history

```
21ce68@U616A-04:/home/administrator/CSPIT/CE$ history
    1  cat file6.txt file7.txt > file8.txt
    2  cat file6.txt
    3  cat file6.txt file7.txt
    4  cat file6.txt file7.txt >> file8.txt
    5  cat file6.txt file7.txt > file8.txt
    6  cat file6.txt file7.txt < file8.txt
    7  sudo cat file6.txt file7.txt > file8.txt
    8  sort -u file6.txt
    9  tr [a-z] [A-Z] < file6.txt
   10  sudo gedit file1.txt
   11  sed 's/[0-9]*//g' file1.txt
   12  head file8.txt
   13  head file7.txt
   14  head -5  file7.txt
   15  tail -2 file7.txt
   16  tail -n 2 file7.txt
   17  man head
   18  less file7.txt
   19  more file7.txt
   20  sudo gedit file9.txt
   21  grep -f "Linux" file9.txt
   22  cat file9.txt
   23  grep "Linux" file9.txt
   24  grep "^OS.$" file9.txt
   25  grep "^Linux" file9.txt
   26  grep "os.$" file9.txt
```

Exercise 1

Try the following command sequence
1. Display username of current user.
2. Display current working directory.
3. Make a sub directory named CE in a directory named CSPIT.
4. Create an empty file “ce1.txt” from command prompt.
5. Add the content from command prompt in “ce1.txt”.
6. Display the content of “ce1.txt” file.
7. Change working directory to CE.
8. Make 5 empty files named file1.txt to file5.txt in same directory.
9. List all the files in the directory CE.
10. Add the Name, ID no, and address with pin code to “file1.txt”.
11. Copy contents of file1.txt to file2.txt.
12. Rename file3.txt to “f3.txt”.
13. Display the number of lines, number of words, number of characters of “file1.txt”.
14. Compare the files “file1.txt” to “file2.txt”
15. Update the content of “file2.txt”. Add your skill to existing file.
16. Compare the files “file1.txt” to “file2.txt”
17. Report what is common in the above given files.
18. Add the content in “file4.txt” as given:
India
United States of America
United Kingdom

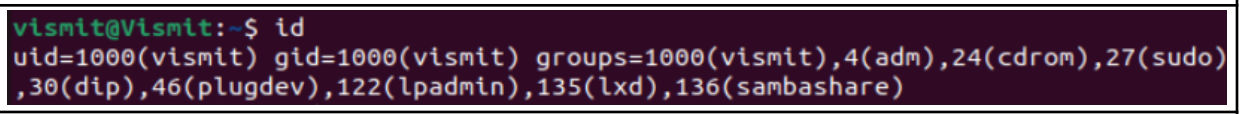
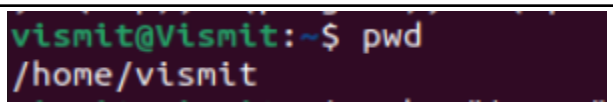
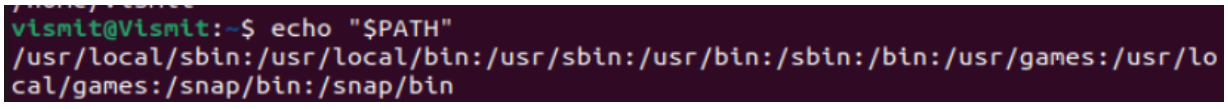
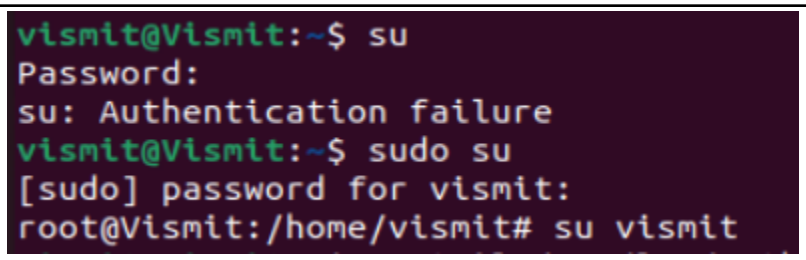
	Australia 19. Add the content in “file5.txt” as given: India Canada United Kingdom Australia Germany 20. Find the difference between “file4.txt” and “file5.txt”. How to make these files identical? 21. Create “file6.txt” by adding ten name of students. 22. Create “file7.txt” by adding ten name of students.(few names should be common to “file6.txt”) 23. Sort the content of “file6.txt” and “file7.txt” 24. Find the common and unique content in “file6.txt” and “file7.txt” 25. Merge the content of above two files in “file8.txt” 26. Remove the duplicate names from “file8.txt” 27. Translate the content of “file1.txt”: a. Lower case to upper case b. Remove digits from file 28. Apply head and tail command to see the content of “file8.txt” with different arguments. 29. Differentiate between less and more command and check why less is faster than more command. 30. Create a file “file9.txt” having content: Linux is great os. Linux is open source. Linux is free os. You can learn operating system with linux. Unix or linux which one you choose. liNux is easy to learn. Linux is a multiuser os. Learn linux. Linux is a powerful. 31. Find the lines which contains “linux”. 32. Count the number of lines that matches the “linux” 33. Show the line number of file with the line matched 34. Find the lines which start with “linux” 35. Find the lines which ends with “os” 36. Display the file name that contains “linux”. 37. Download lab manual from department course website. 38. Check the file type of lab manual and other files created. 39. Display IP address of your system (ip addr) 40. Extract only IP address from this
Output	

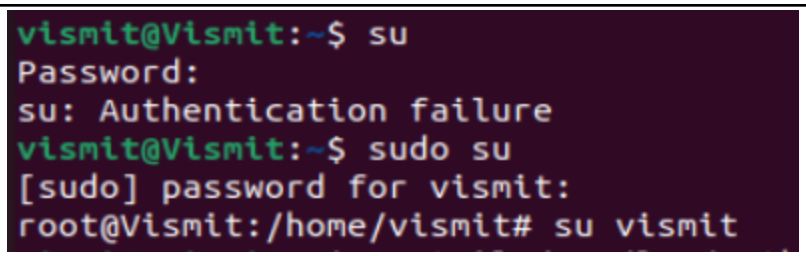
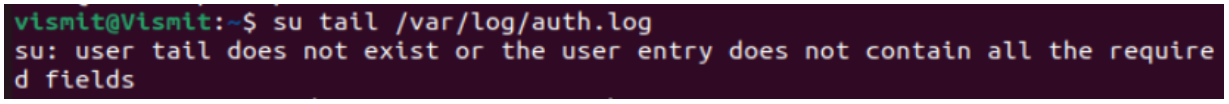
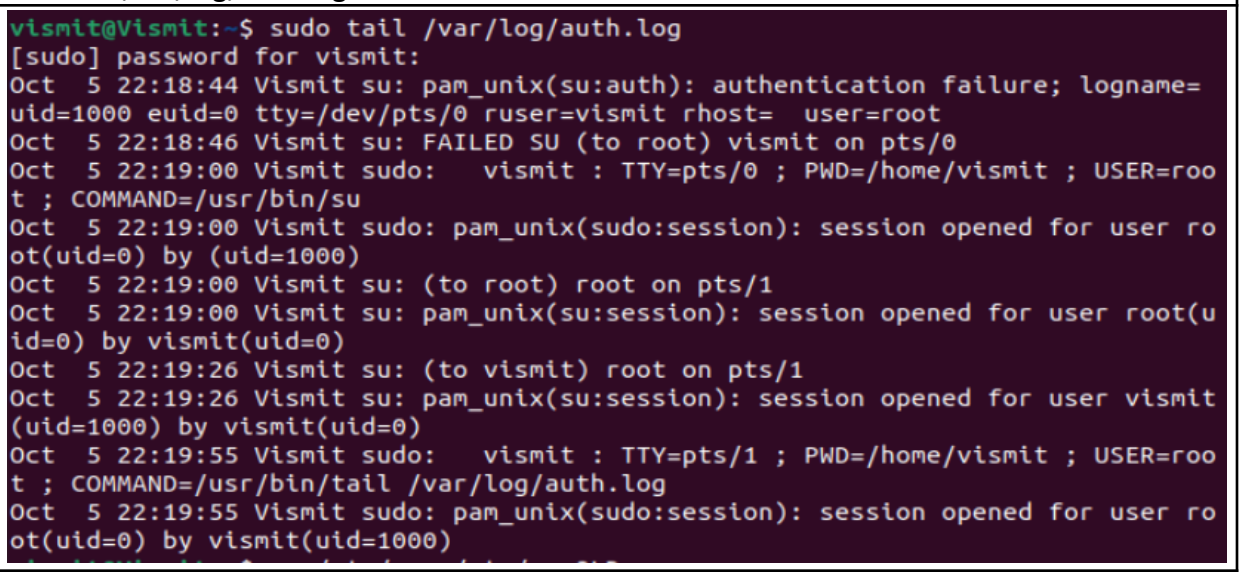
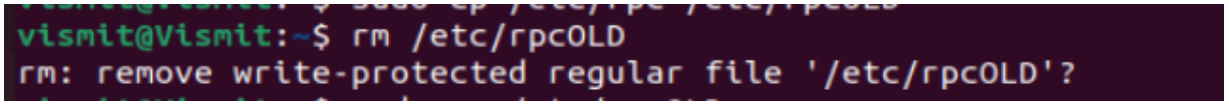
```
  23  grep "Linux" file9.txt
  24  grep "^OS.$" file9.txt
  25  grep "^Linux" file9.txt
  26  grep "os.$" file9.txt
  27  grep -l file9.txt
  28  grep -l "Linux"  file9.txt
  29  wget https://sites.google.com/charusat.ac.in/operating-system/practical-a
ssessment
  30  histroy
  31  history
  32  sudo gedit file2.txt
  33  sudo gedit file5.txt
  34  diff file2.txt file5.txt
  35  sudo gedit file6.txt
  36  cp file6.txt file7.txt
  37  sudo cp file6.txt file7.txt
  38  sudo gedit file7.txt
  39  sudo sort file6.txt
```

```
  40  sudo sort file7.txt
  41  comm < (sort file6.txt) < (file7.txt)
  42  comm < (sort file6.txt) < (sort file7.txt)
  43  comm < uniq  file6.txt < sort file7.txt
  44  comm | sort -u file6.txt
  45  comm | sort -u file6.txt | sort -u file7.txt
  46  cat file6.txt file7.txt > file8.txt
  47  sudo cat file6.txt file7.txt > file8.txt
  48  su administrator
  49  history
  50  ls
  51  cmp f1.txt file2.txt
  52  comm file1.txt file2.txt
  53  sudo gedit file2.txt
  54  su administrator
  55  ipconfig
  56  network
  57  whoami
  58  ls -l
  59  history
```

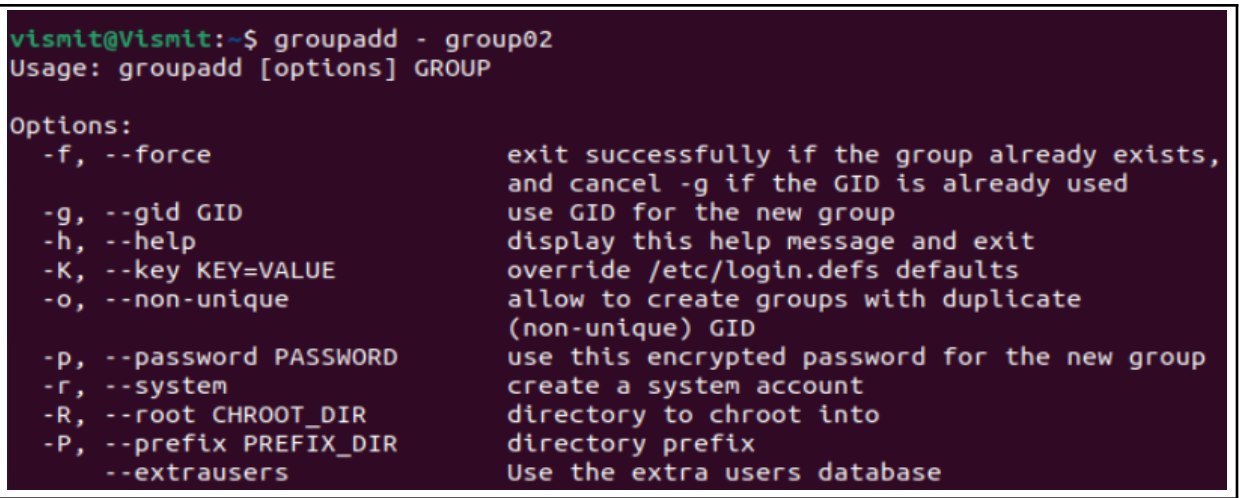
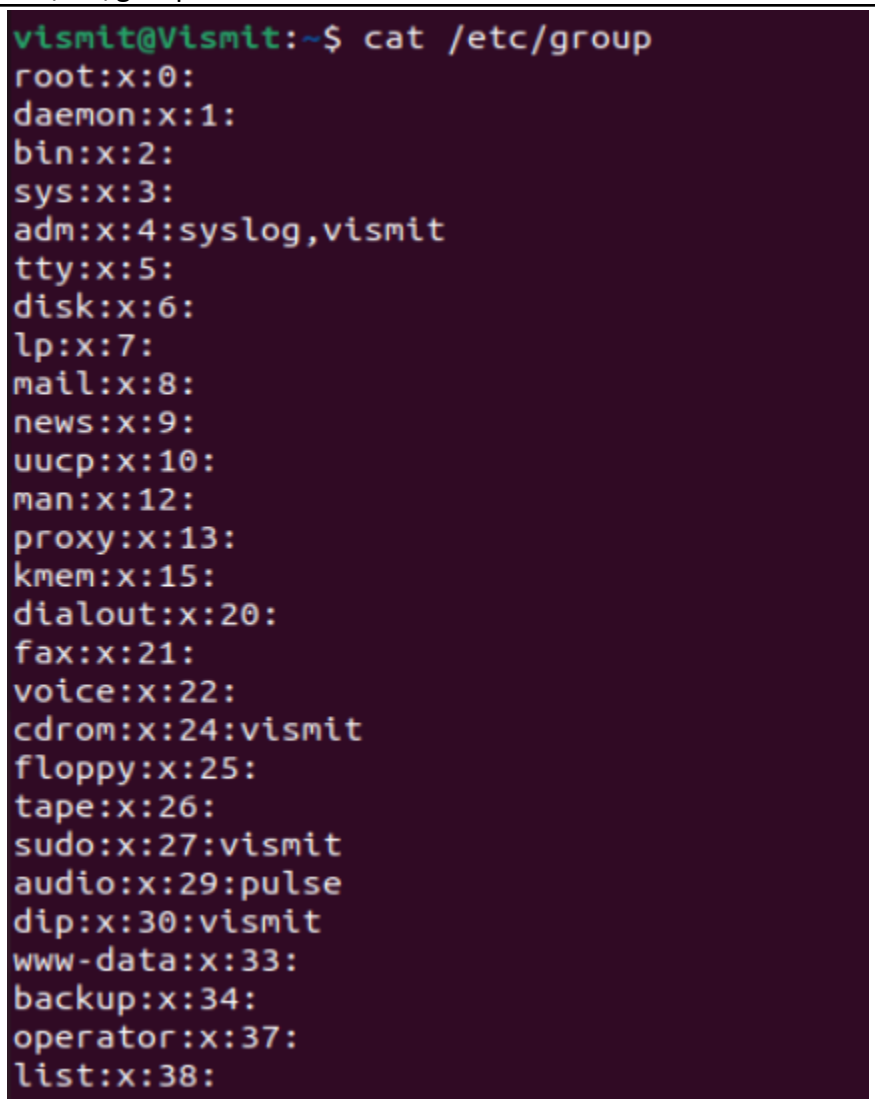
Conclusion	From this practical we learned how to create user along with its functionalities like password and create files with functionalities like copy one file to another and so on.

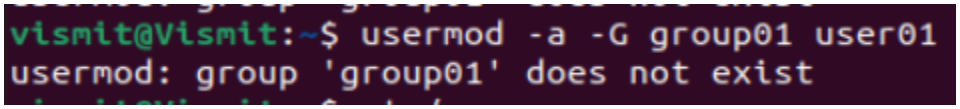
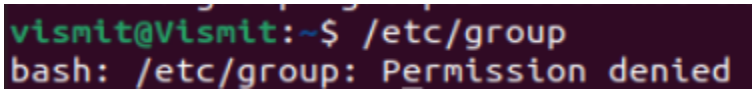
Practical-3

	Exercise PART A
Aim	Run id command to view the current user and group information.
Command	Id
Output	
Aim	display the current working directory.
Command	Pwd
Output	
Aim	print the value of HOME and PATH variable to determine the home directory and user's executable's path respectively.
Command	Echo "$PATH"
Output	
Aim	Run su and su - command. Observe the output for the same.what is the main difference between them?
Command	Su Sudo su
Output	
Aim	Run sudo su at the shell prompt to become the root user.
Command	Sudo su

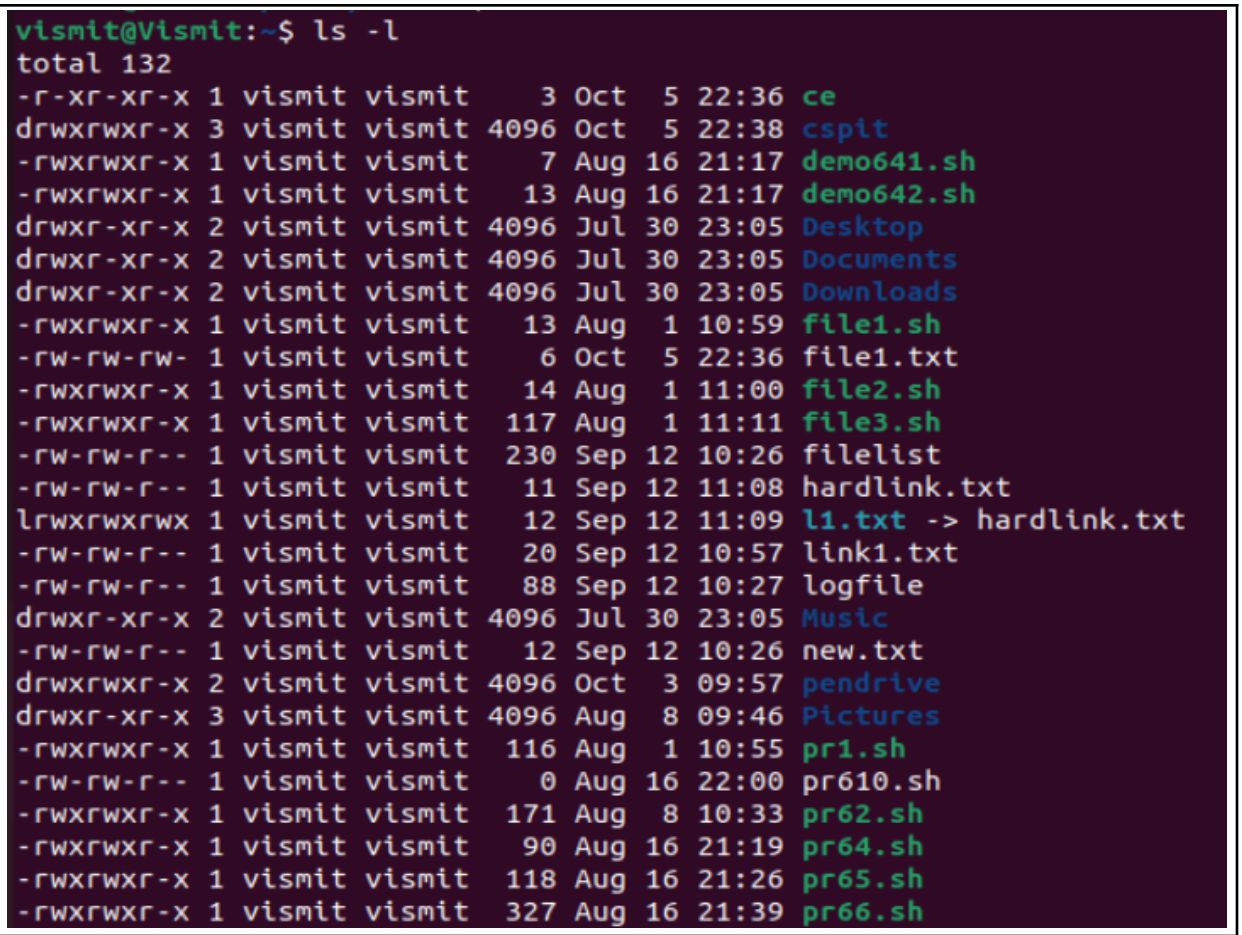
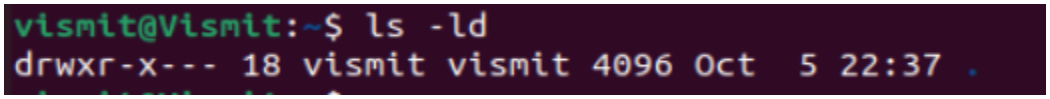
Output	
Aim	Attempt to view the last five lines of /var/log/auth.log without using sudo
Command	Su tail /var/log/auth.log
Output	
Aim	Attempt to view the last five lines of /var/log/auth.log using sudo
Command	Sudo tail /var/log/auth.log
Output	
Aim	Attempt to make a copy of /etc/rpc as /etc/rpcOLD without using sudo
Command	Cp /etc/rpc as /etc/rpcOLD
Output	
Aim	Attempt to make a copy of /etc/rpc as /etc/rpcOLD with sudo.
Command	Sudo cp /etc/rpc as /etc/rpcOLD
Output	
Aim	Attempt to delete /etc/rpcOLD without using sudo
Command	Rm /etc/rpcOLD
Output	
Aim	Attempt to delete /etc/rpcdOLD with sudo
Command	Sudo rm /etc/rpcOLD

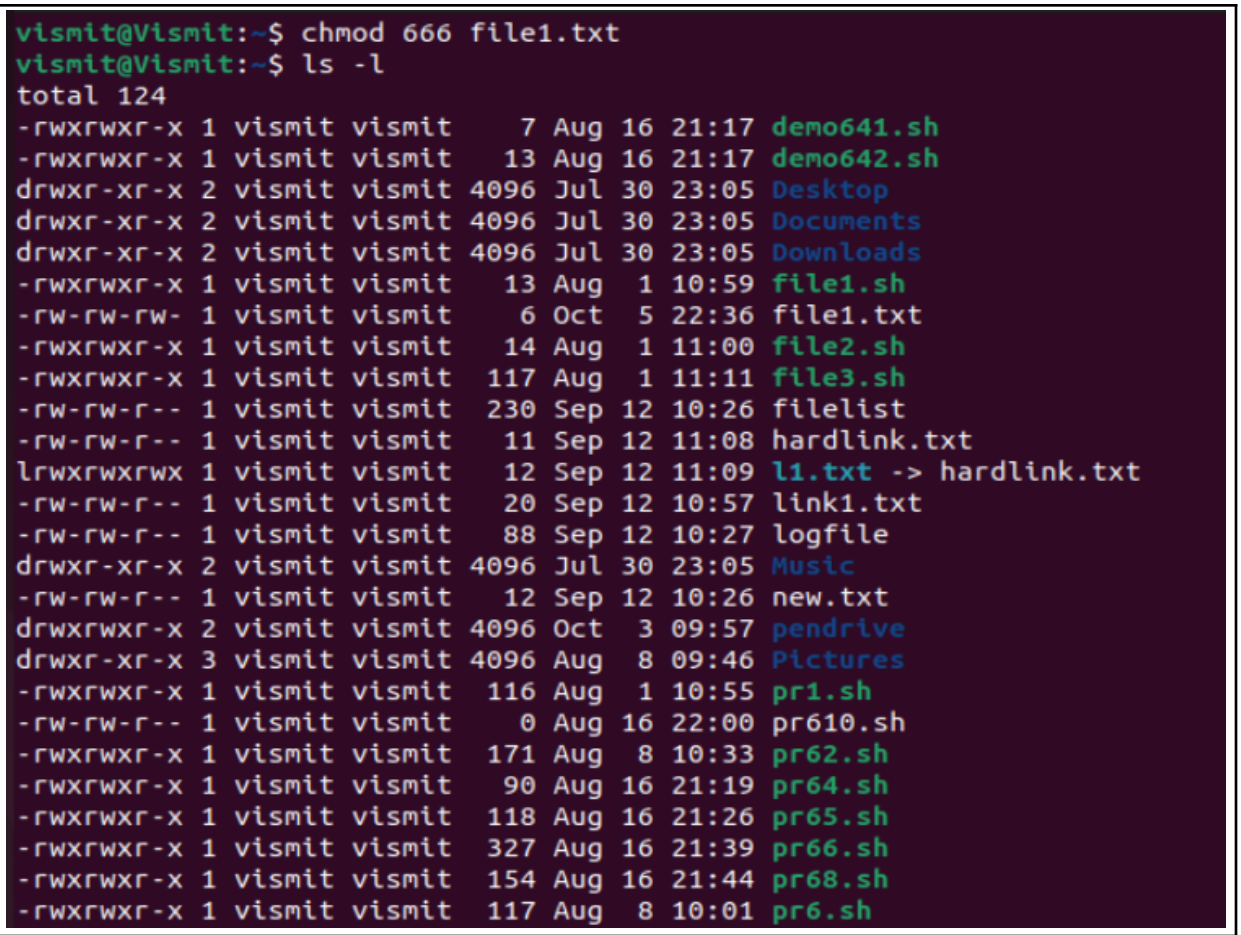
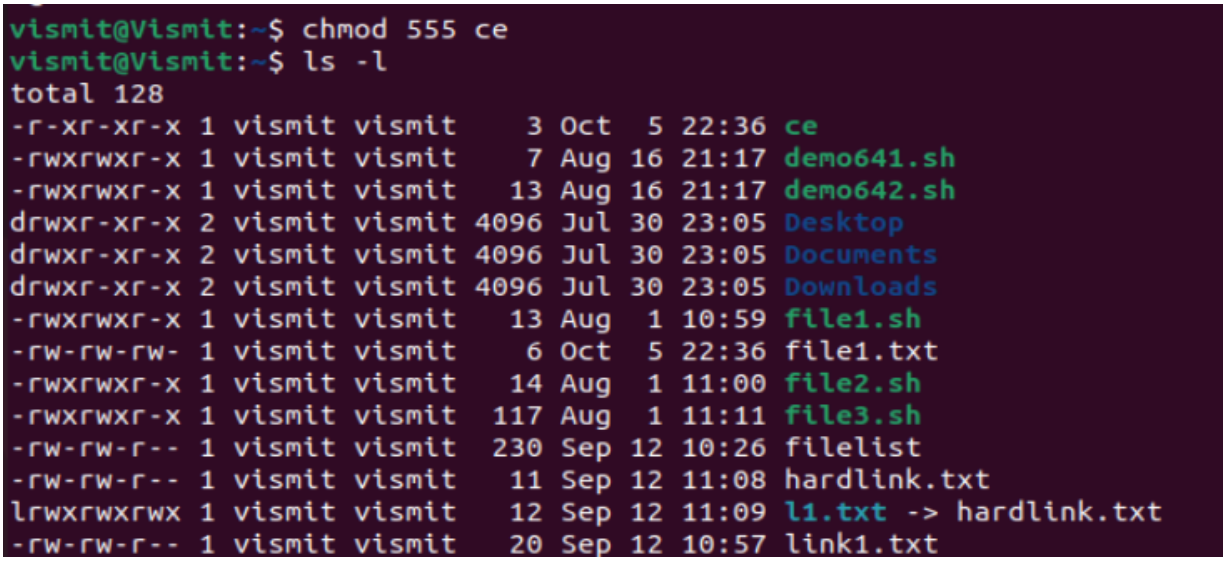
Output	vismit@Vismit:~$ sudo rm /etc/rpcOLD
Aim	check the UID for root user, administrator and local users.
Command	id
Output	vismit@Vismit:~$ id uid=1000(vismit) gid=1000(vismit) groups=1000(vismit),4(adm),24(cdrom),27(sudo),30(dip),46(plugdev),122(lpadmin),135(lxd),136(sambashare)
Aim	Adduser user01.
Command	Sudo adduser user01 –force-badname
Output	vismit@Vismit:~$ sudo adduser user01 --force-badname Adding user `user01' ... Adding new group `user01' (1004) ... Adding new user `user01' (1003) with group `user01' ... Creating home directory `/home/user01' ... Copying files from `/etc/skel' ... New password: Retype new password: passwd: password updated successfully Changing the user information for user01 Enter the new value, or press ENTER for the default Full Name []: Room Number []: Work Phone []: Home Phone []: Other []: Is the information correct? [Y/n]
Aim	Create the group group01 with the GID of 10000.
Command	Groupadd -g 10000 group group01
Output	vismit@Vismit:~$ groupadd -g 10000 group group01 Usage: groupadd [options] GROUP Options: -f, --force exit successfully if the group already exists, and cancel -g if the GID is already used -g, --gid GID use GID for the new group -h, --help display this help message and exit -K, --key KEY=VALUE override /etc/login.defs defaults -o, --non-unique allow to create groups with duplicate (non-unique) GID -p, --password PASSWORD use this encrypted password for the new group -r, --system create a system account -R, --root CHROOT_DIR directory to chroot into -P, --prefix PREFIX_DIR directory prefix --extrausers Use the extra users database
Aim	Create the group group02
Command	Groupadd -group02

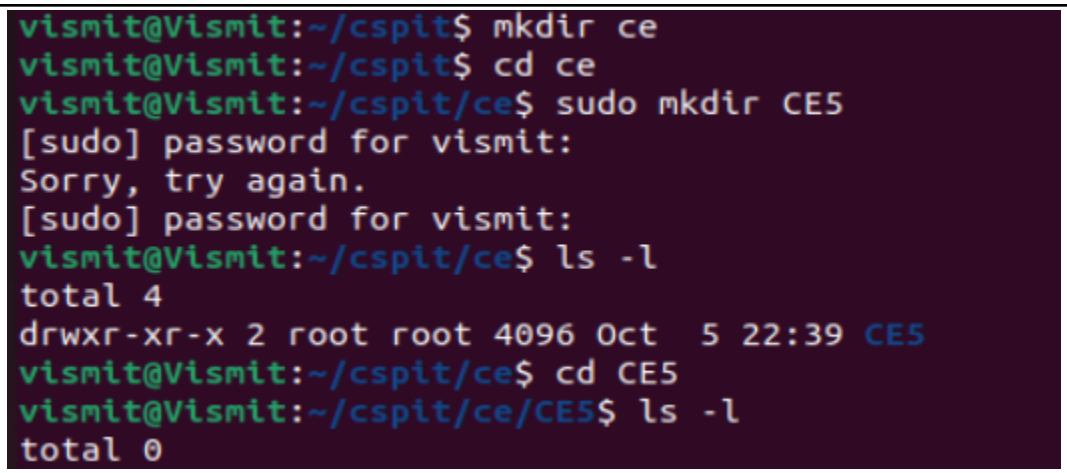
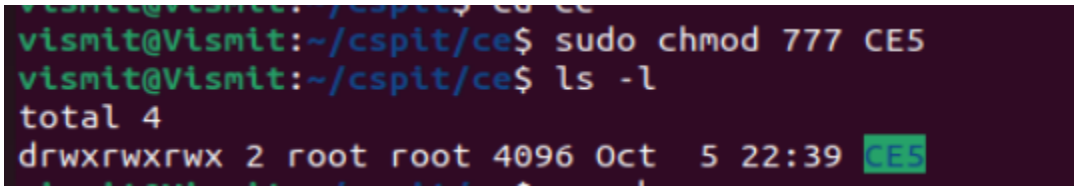
Output	
Aim	Examine /etc/group to verify the supplemental group memberships.
Command	Cat /etc/group
Output	
Aim	Use the usermod -aG command to add a user to a supplementary group. Add user01 to

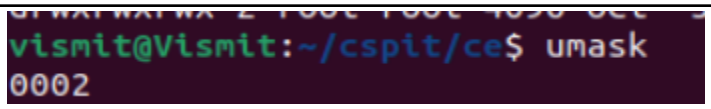
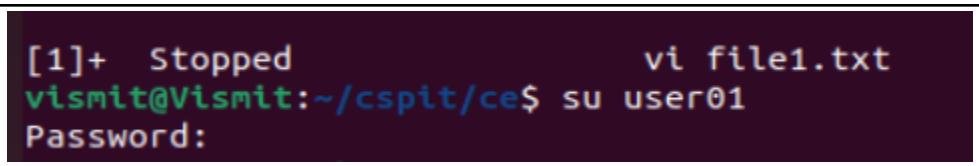
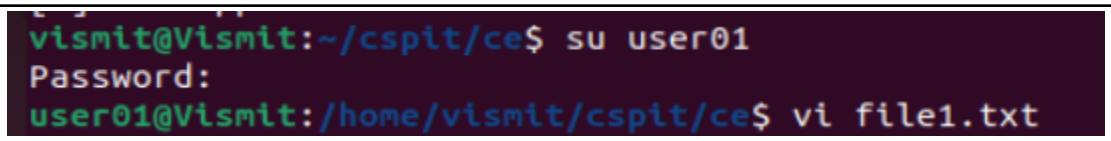
	the group created.
Command	Usermod -a -G group01 user01
Output	
Aim	Observe /etc/group and /etc/passwd
Command	/etc/group
Output	

	PART B Aim : Control access to files
Aim	Check the permission of files created.
Command	Ls -l

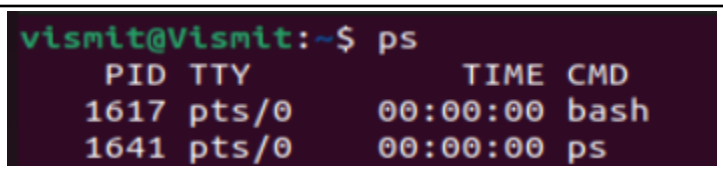
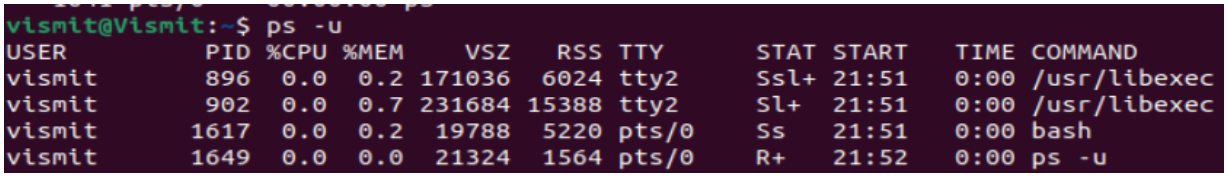
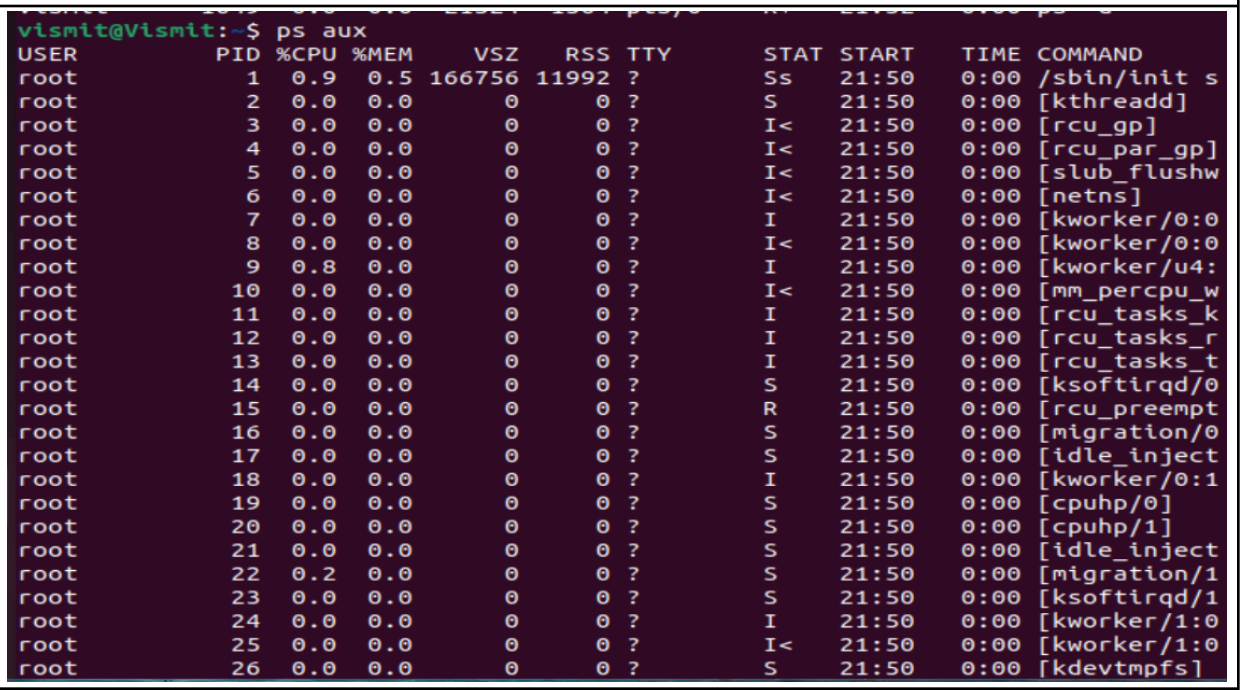
Output	
Aim	Check the permission of directories created.
Command	Ls -ld
Output	
Aim	Set read and write permissions for others with numeric mode to file1.txt
Command	Chmod 666 file1.txt

Output	
Aim	Remove write permission for user, group and others to folder CE.
Command	Chmod 555 ce
Output	
Aim	Create a directory 5CE under CE. Observe the response.
Command	Cd ce Sudo mkdir CE5

	Cd ce5 Ls -l
Output	
Aim	Set read, write and execute permissions for user, group and others to 5CE.
Command	Sudo chmod 777 CE5
Output	
Aim	Set read and execute permission for group and no permission for other to file2.txt.
Command	Chmod 750 file2.txt
Aim	Change the ownership of file to user01
Command	Sudo chown user01 file2.txt Ls -l
Aim	Change the group ownership of file to group01
Command	Sudo chown :user01 file2.txt Ls -l
Aim	Change the ownership of both group and user at the same time.
Command	Sud chown user01:user01 file4.txt Ls -l
Aim	Set the special permissions on directory. a. The setuid permission on an executable file means that commands run as the user owning the file, not as the user that ran the command. One example is the passwd command:run ls -l /usr/bin/passwd b. The special permission setgid on a directory means that files created in the directory inherit their group ownership from the directory, rather than inheriting it from the creating user. run ls -ld /run/log/journal c. the sticky bit for a directory sets a special restriction on deletion of files. Only the owner of the file (and root) can delete files within the directory. run ls -ld /tmp
Command	a) run ls -l /usr/bin/passwd

	b) ls -ld /run/log/journal c) ls -ld /tmp
Aim	Set the setusid, setgid and sticky bit for different files and perform the operations accordingly.
Aim	Display the current value of shell's mask.
Command	umask
Output	
Aim	Set the umask to 542.
Command	Umask 542
Output	
Aim	Try to open the file and directory created.
Command	Vi file1.txt
Output	
Aim	Try to open the file as other user
Command	Su user01 Vi file1.txt
Output	

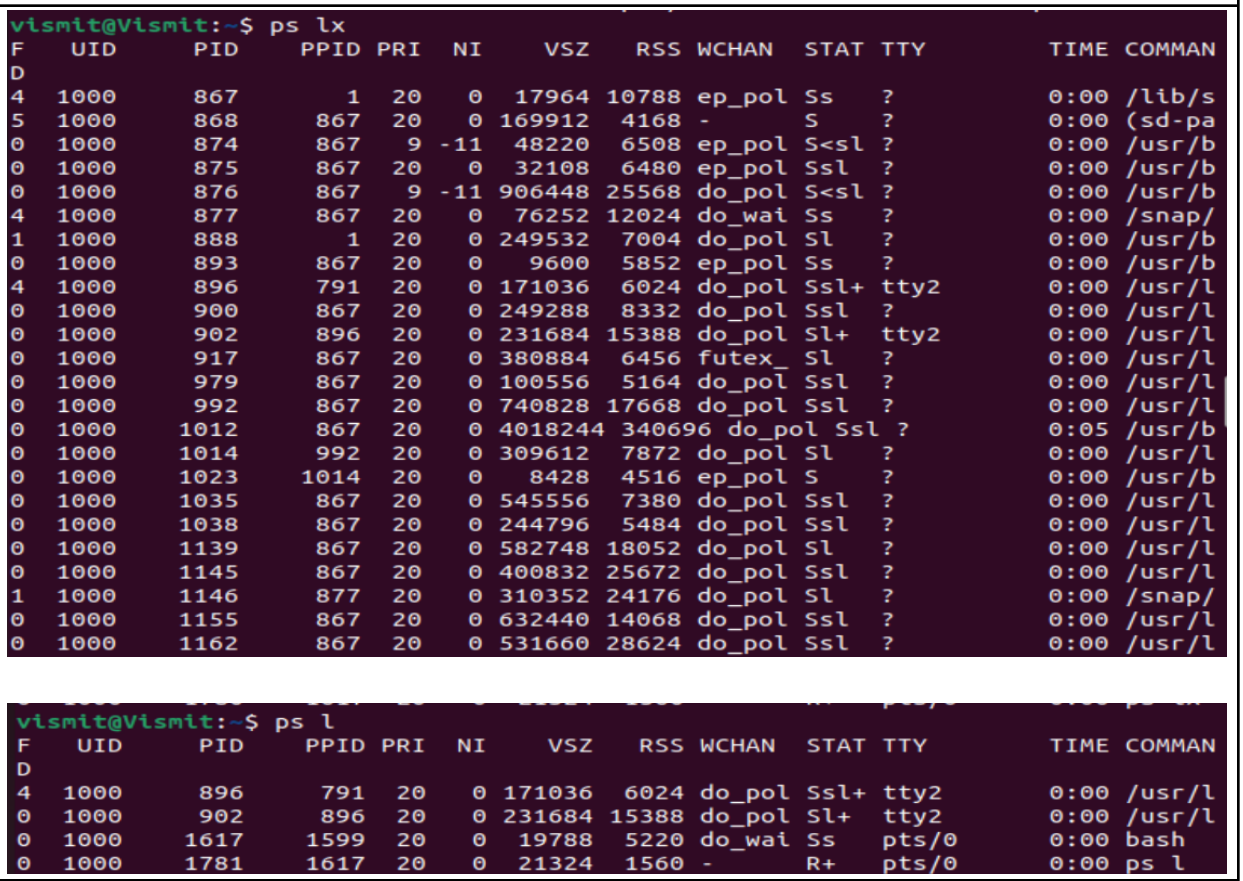
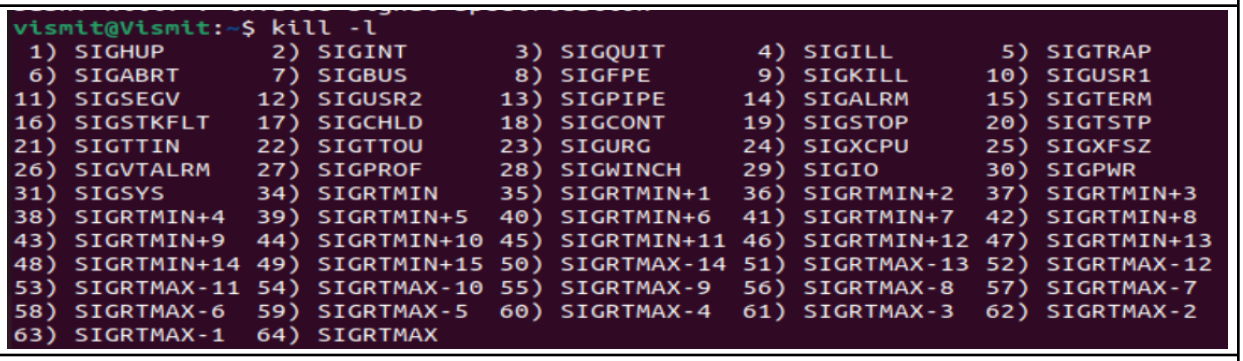
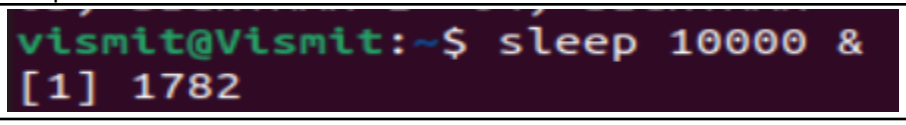
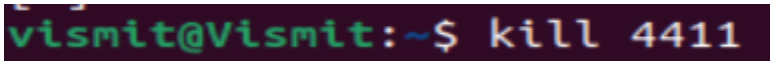
Practical-4

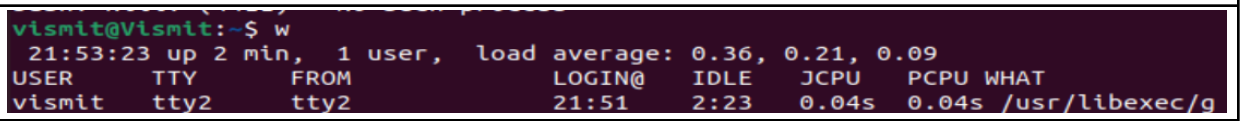
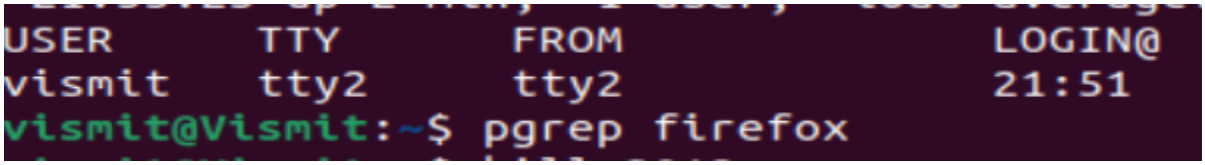
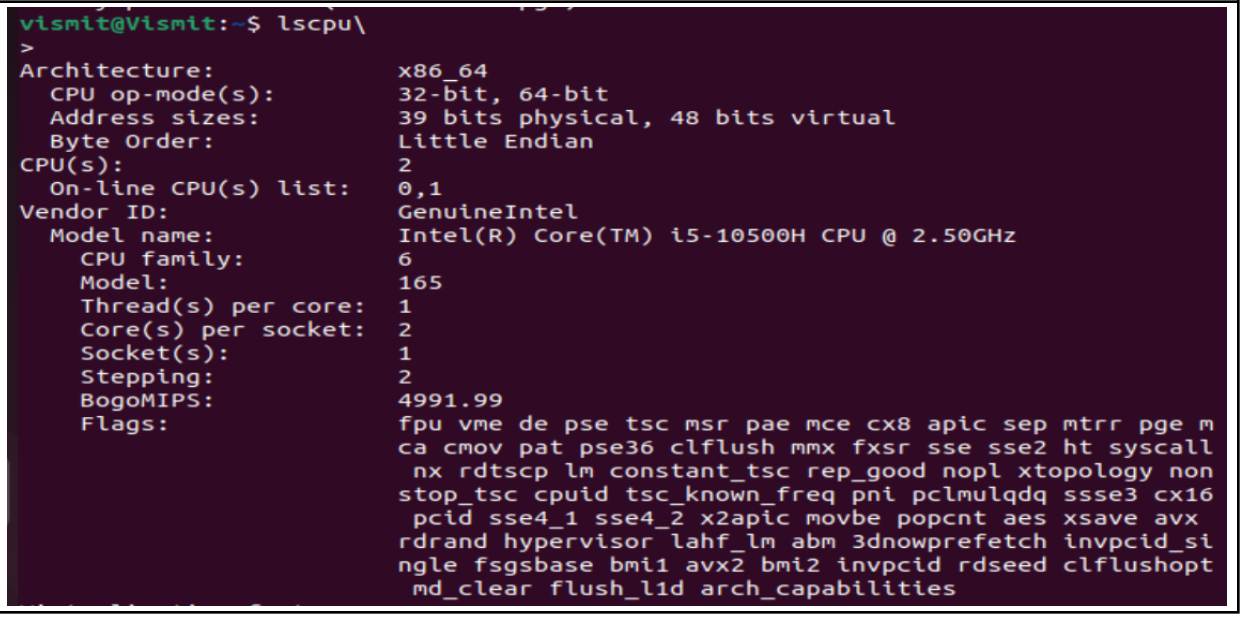
AIM	List down all processes with their states sorted by their CPU Usage. Identify current running process.
Command	Ps
Output	
AIM	List down all processes associated with current user.
Command	Ps -u
Output	
AIM	List down all processes associated with their terminal and their states. Identify current running process.
Command	Ps aux
Output	
AIM	Compare the output of “ps lx” and “ps l” commands.
Command	Ps lx

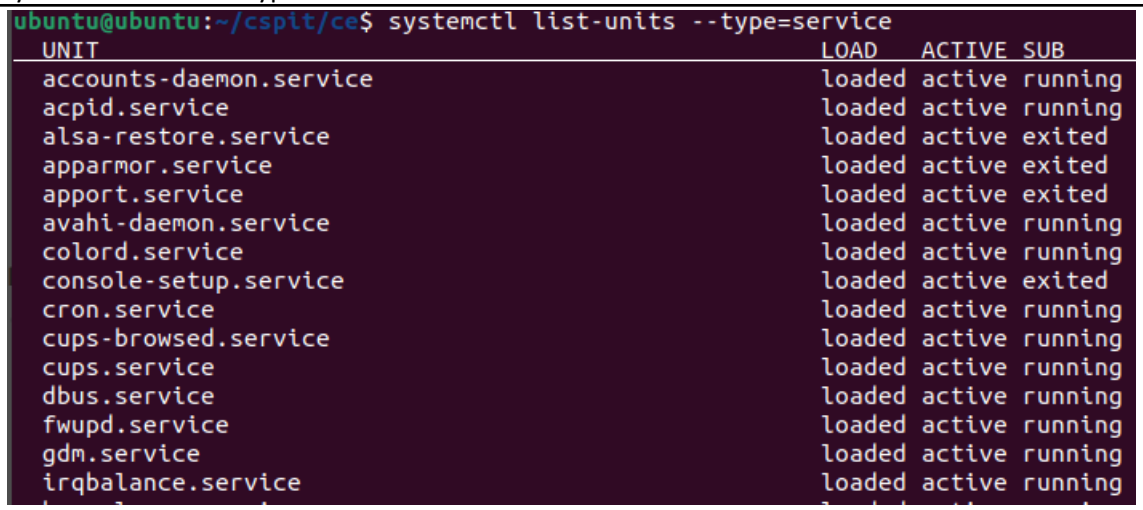
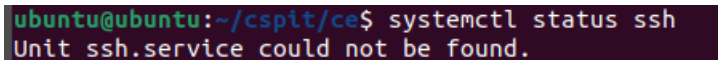
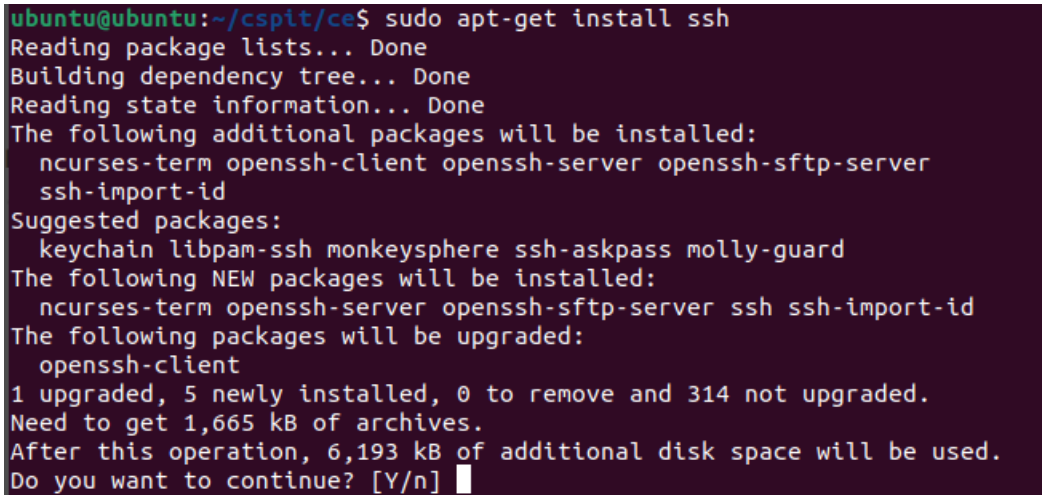
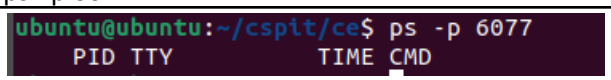
```
vismit@Vismit:~$ ps
    PID TTY          TIME CMD
   1617 pts/0    00:00:00 bash
   1641 pts/0    00:00:00 ps
```

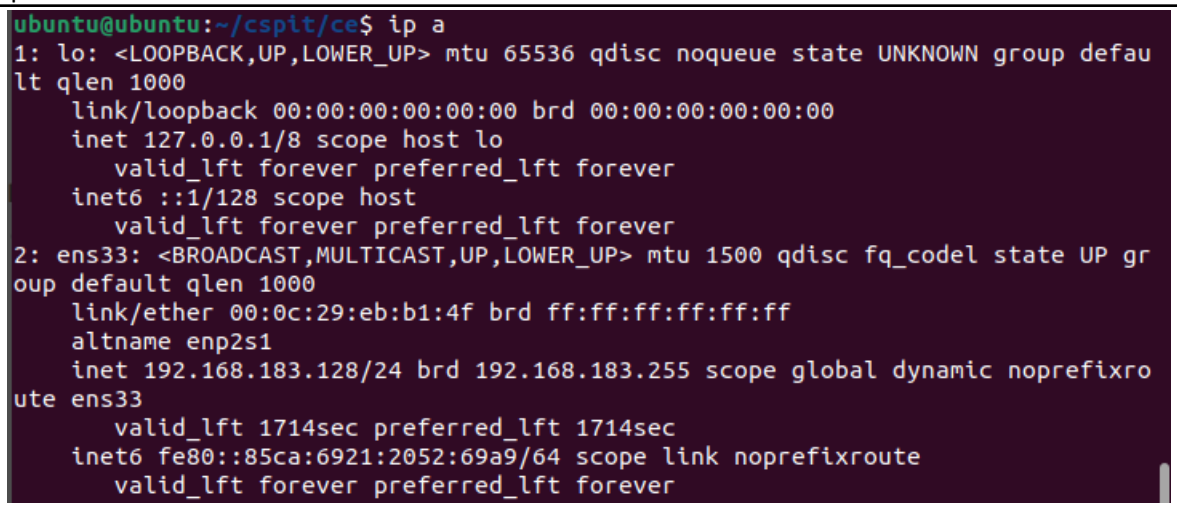
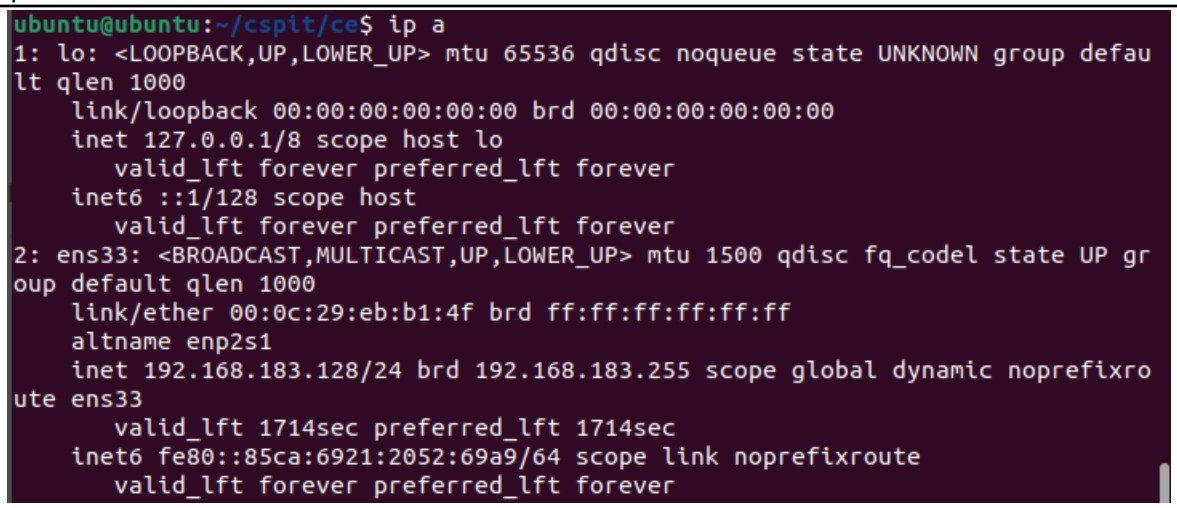
```
vismit@Vismit:~$ ps -u
USER         PID %CPU %MEM    VSZ   RSS TTY      STAT START   TIME COMMAND
vismit       896  0.0  0.2 171036  6024 tty2     Ssl+ 21:51   0:00 /usr/libexec
vismit       902  0.0  0.7 231684 15388 tty2     Sl+  21:51   0:00 /usr/libexec
vismit      1617  0.0  0.2  19788  5220 pts/0    Ss   21:51   0:00 bash
vismit      1649  0.0  0.0  21324  1564 pts/0    R+   21:52   0:00 ps -u
```

```
vismit@Vismit:~$ ps aux
USER         PID %CPU %MEM    VSZ   RSS TTY      STAT START   TIME COMMAND
root           1  0.9  0.5 166756 11992 ?        Ss   21:50   0:00 /sbin/init s
root           2  0.0  0.0      0     0 ?        S    21:50   0:00 [kthreadd]
root           3  0.0  0.0      0     0 ?        I<   21:50   0:00 [rcu_gp]
root           4  0.0  0.0      0     0 ?        I<   21:50   0:00 [rcu_par_gp]
root           5  0.0  0.0      0     0 ?        I<   21:50   0:00 [slub_flushw
root           6  0.0  0.0      0     0 ?        I<   21:50   0:00 [netns]
root           7  0.0  0.0      0     0 ?        I    21:50   0:00 [kworker/0:0
root           8  0.0  0.0      0     0 ?        I<   21:50   0:00 [kworker/0:0
root           9  0.8  0.0      0     0 ?        I    21:50   0:00 [kworker/u4:
root          10  0.0  0.0      0     0 ?        I<   21:50   0:00 [mm_percpu_w
root          11  0.0  0.0      0     0 ?        I    21:50   0:00 [rcu_tasks_k
root          12  0.0  0.0      0     0 ?        I    21:50   0:00 [rcu_tasks_r
root          13  0.0  0.0      0     0 ?        I    21:50   0:00 [rcu_tasks_t
root          14  0.0  0.0      0     0 ?        S    21:50   0:00 [ksoftirqd/0
root          15  0.0  0.0      0     0 ?        R    21:50   0:00 [rcu_preempt
root          16  0.0  0.0      0     0 ?        S    21:50   0:00 [migration/0
root          17  0.0  0.0      0     0 ?        S    21:50   0:00 [idle_inject
root          18  0.0  0.0      0     0 ?        I    21:50   0:00 [kworker/0:1
root          19  0.0  0.0      0     0 ?        S    21:50   0:00 [cpuhp/0]
root          20  0.0  0.0      0     0 ?        S    21:50   0:00 [cpuhp/1]
root          21  0.0  0.0      0     0 ?        S    21:50   0:00 [idle_inject
root          22  0.2  0.0      0     0 ?        S    21:50   0:00 [migration/1
root          23  0.0  0.0      0     0 ?        S    21:50   0:00 [ksoftirqd/1
root          24  0.0  0.0      0     0 ?        I    21:50   0:00 [kworker/1:0
root          25  0.0  0.0      0     0 ?        I<   21:50   0:00 [kworker/1:0
root          26  0.0  0.0      0     0 ?        S    21:50   0:00 [kdevtmpfs]
```

	Ps l
Output	
AIM	List down all the names and numbers of all available signals.
Command	Kill -l
Output	
AIM	Run the “sleep 10000” in background. (i.e. sleep 10000 &)
Command	Sleep 10000 &
Output	
AIM	Check the PID of sleep process and kill it using PID.
Command	Kill 4411
Output	
AIM	Apply w command and observer the output

Command	w
Output	
AIM	Open the firefox browser. Check the processes associated with firefox.
Command	Pgrep firefox
Output	
AIM	Kill all processes associated with firefox by its name.
Command	Kill 3012
Output	
AIM	Give the difference between kill and pkill.
Command	Kill Pkill
Output	pkill is similar to kill, but it allows you to send signals to processes based on their name or other attributes.
AIM	Run “lscpu” command and observer the output.
Command	lscpu
Output	

	PART B Aim : Control Services and daemons
AIM	List all services on your system.(systemctl list-units --type=service)
Command	systemctl list-units --type=service
Output	
AIM	Check whether the ssh service is active or not. (sudosystemctl status service_name)
Command	sudosystemctl status ssh
Output	
AIM	If the package is not available, i nstall ssh package (sudo apt-get install ssh)
Command	sudo apt-get install ssh
Output	
AIM	If the service is available and active, check the process state usng ps –p PID
Command	ps –p 6077
Output	
AIM	Add the firewall rule to allow remote service using ssh(sudo ufw allow ssh)

Command	Ip a
Output	
AIM	Check your IP address
Command	Ip a
Output	
AIM	Access another user terminal using ssh
Command	sudo ssh <username>@<any pc's ip address>, it will connect to shell of another linux pc with the specified username and ip address.
AIM	Stop the service and check the status
Output	exit sudo systemctl status ssh, the shell will be exited by "exit" command and we will return to our shell then the status will be stopped.
AIM	Disable the service and check the status
Output	udo stop ssh, it will stop the service permanently
AIM	Enable it again and check the status
Output	sudo start ssh sudo systemctl status ssh, the status of the service will not be changed to "active".
AIM	Restart the service and check the status
Output	sudo systemctl status ssh, the status will be "active start" because it was started already.

AIM	Observe the analyze the output of below mentioned command 1. systemctl is-active ssh 2. systemctl is-enabled ssh 3. systemctl is-failed ssh
Output	a. systemctl is-active ssh, it will check that whether the service is active or not b. systemctl is-enabled ssh, similarly it will check of enable c. systemctl is-failed ssh, similarly it will check whether the service is enabled or not?

	PART C Aim: Improve Command Line Productivity I/o Redirection
AIM	Create a file named “newfile.txt” and insert a text into created file as follow: The operating system is a system program that serves as an interface between the computing system and the end-user.
Command	
Output	`ubuntu@ubuntu:~/cspit/ce$ sudo cat newfile.txt` `The oprating syatem is a system program that serves as an interface between the computing system and the end-user.`
AIM	
Command	Redirect the output of “newfile.txt” file to file “new.txt” using command.

Output	`ubuntu@ubuntu:~/cspit/ce$ sudo cat newfile.txt > new.txt`
	`ubuntu@ubuntu:~/cspit/ce$ sudo cat new.txt`
	`The oprating syatem is a system program that serves as an interface between the computing system and the end-user.`

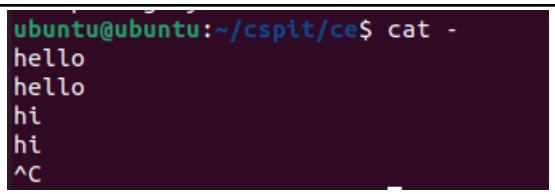
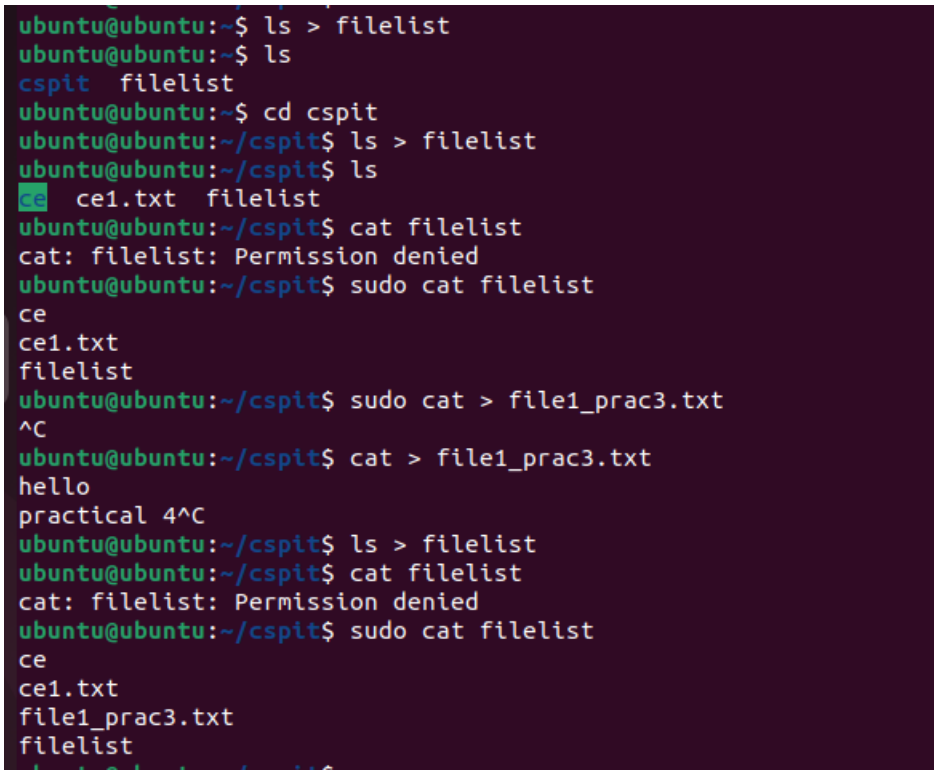
AIM	Type command cat, then enter key and enter some text. Observe the output.
Command	

Output	`ubuntu@ubuntu:~/cspit/ce$ cat`
	`hello cat from practical 4`
	`hello cat from practical 4`
	`good morning`
	`good morning`
	`^C`

AIM	Type command i) cat <newfile.txt ii) cat newfile.txt. Interpret the output in both cases.
Command	

Output	`ubuntu@ubuntu:~/cspit/ce$ cat < newfile.txt`
	`-bash: newfile.txt: Permission denied`
	
	`ubuntu@ubuntu:~/cspit/ce$ sudo cat newfile.txt`
	`The oprating syatem is a system program that serves as an interface between the computing system and the end-user.`

AIM	Type command cat – and enter any text.
Command	

Output	
AIM	Use both redirection operator < and > at once to redirect the output of one file to another.
Command	cat < input_file.txt > output_file.txt
AIM	Summarize the use of cat command with redirection operator based on your done exercise.
ANS	There are mainly three symbols that we can use to optimise the file reading, writing operations. The first operator is “>” this operator takes the thing on the left of it as input and redirects it to the thong which is on the right. The operator “<” takes the thing on let of it, as output and redirects it to the thing which is on the left.
AIM	Try following command andinterpret the output: a) ls >filelist b) cat newfile.txt new.txt >> report c) cat newfile.txt > newfile.txt d) date; who e) date; who>logfile f) (date; who) > logfile
Output	A)  B)

```
ubuntu@ubuntu:~/cspit$ sudo cat file1_prac4.txt filelist >> repot
ubuntu@ubuntu:~/cspit$ ls
ce  ce1.txt  file1_prac3.txt  file1_prac4.txt  filelist  repot
ubuntu@ubuntu:~/cspit$ cat repot
cat: repot: Permission denied
ubuntu@ubuntu:~/cspit$ sudo cat repot
hello
practical 4
ce
ce1.txt
file1_prac3.txt
filelist
```

C)

```
ubuntu@ubuntu:~/cspit$ ls
ce  ce1.txt  file1_prac3.txt  file1_prac4.txt  filelist  repot
ubuntu@ubuntu:~/cspit$ sudo cat filelist
ce
ce1.txt
file1_prac3.txt
filelist
ubuntu@ubuntu:~/cspit$ sudo cat file1_prac4.txt
hello
practical 4
ubuntu@ubuntu:~/cspit$ sudo cat filelist > filelist
ubuntu@ubuntu:~/cspit$ sudo cat filelist
```

D)

```
ubuntu@ubuntu:~/cspit$ date; who
Friday 11 August 2023 10:12:19 PM IST
kush     tty2         2023-08-11 17:52 (tty2)
kush     pts/0        2023-08-11 18:38
```

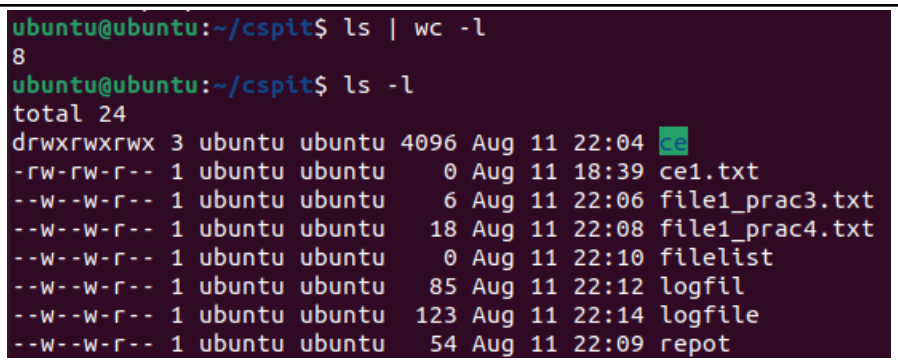
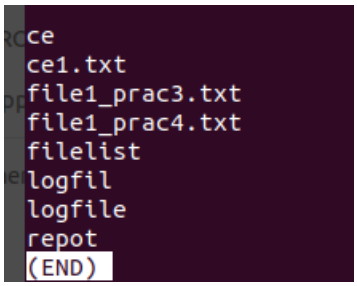
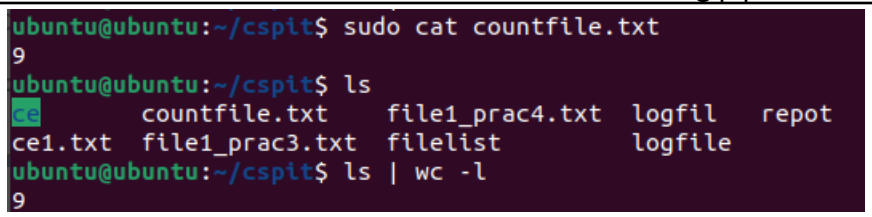
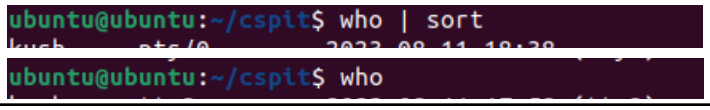
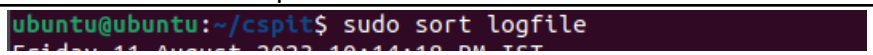
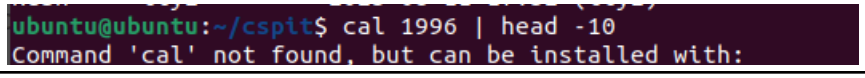
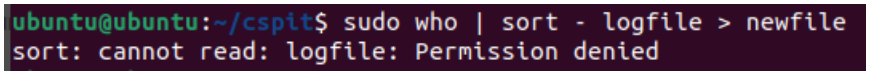
E)

```
ubuntu@ubuntu:~/cspit$ date; who>logfile
Friday 11 August 2023 10:12:54 PM IST
```

F)

```
ubuntu@ubuntu:~/cspit$ (date; who) > logfile
```

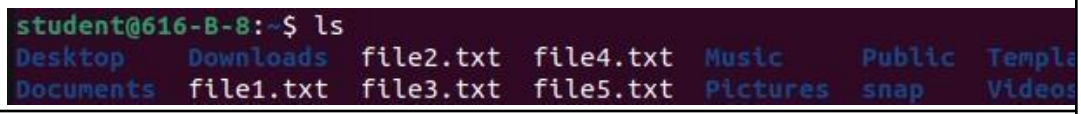
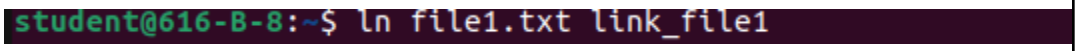
	Piping
AIM	ls | wc -l

Output	
AIM	ls | less
Output	
AIM	store the value of count in file named “countfile” using pipeline.
Output	
AIM	Try command who | sort and observe the output.
Output	
AIM	Strore the sorted output in file named “sortedlist”
Output	
AIM	Try cal 1996 | head -10
Output	
AIM	Who | sort – logfile >newfile
Output	

Practical 5

Part A

1	The File Hierarchy Standard (FHS) is a specification that defines the file system hierarchy of a Linux OS. Illustrate about the use of all directories under the "\" as given in the figure.
Ans.	/bin: Contains essential binary executables. /boot: Contains boot-related files. /dev: Contains device files. /etc: Contains system-wide configuration files. /lib: Contains essential shared libraries. /proc: Contains information about processes and system status. /root: Home directory of the system administrator (root). /sbin: Contains system binaries. /tmp: Temporary files. /usr: Contains secondary hierarchy, including user and system programs. /var: Contains variable data, like logs and spool files.
	@ubuntu:~$ /boot bash: /boot: Is a directory @ubuntu:~$ /bin bash: /bin: Is a directory @ubuntu:~$ /dev bash: /dev: Is a directory @ubuntu:~$ /etc bash: /etc: Is a directory @ubuntu:~$ /lib bash: /lib: Is a directory @ubuntu:~$ /proc bash: /proc: Is a directory @ubuntu:~$ /root bash: /root: Is a directory @ubuntu:~$ /sbin

	bash: /sbin: Is a directory @ubuntu:~$ /tmp bash: /tmp: Is a directory @ubuntu:~$ /usr bash: /usr: Is a directory @ubuntu:~$ /var bash: /var: Is a directory
2)	List out files in your directory.
Ans)	Command: ls List Files in Current Directory 
3)	Create a hard link to one of the file exist in your directory. (ln [original file] [link name])
Ans)	Command:ln file1.txt link_file1 Create a hard link with 
4)	Apply ls –l and check whether the link is created or not. Also check the size of linked file created.
Ans)	Command:ls -l check if the link is created, and verify the size of the linked file.

```
student@616-B-8:~$ ln file1.txt link_file1
student@616-B-8:~$ ls -l
total 36
drwxr-xr-x 3 student student 4096 Sep 16 10:52 Desktop
drwxr-xr-x 2 student student 4096 Aug 16 22:18 Documents
drwxr-xr-x 3 student student 4096 Aug 18 14:28 Downloads
-rw-rw-r-- 2 student student    0 Sep 21 12:23 file1.txt
-rw-rw-r-- 1 student student    0 Sep 21 12:23 file2.txt
-rw-rw-r-- 1 student student    0 Sep 21 12:23 file3.txt
-rw-rw-r-- 1 student student    0 Sep 21 12:23 file4.txt
-rw-rw-r-- 1 student student    0 Sep 21 12:23 file5.txt
-rw-rw-r-- 2 student student    0 Sep 21 12:23 link_file1
drwxr-xr-x 2 student student 4096 Aug 16 22:18 Music
drwxr-xr-x 3 student student 4096 Sep 11 10:51 Pictures
drwxr-xr-x 2 student student 4096 Aug 16 22:18 Public
drwx------ 4 student student 4096 Aug 18 14:28 snap
drwxr-xr-x 2 student student 4096 Aug 16 22:18 Templates
drwxr-xr-x 2 student student 4096 Aug 16 22:18 Videos
```

5) Update the existing file.

Command:gedit file1.txt

```
student@616-B-8:~$ gedit file1.txt
```

6) Apply ls –l and check the size of linked file created.

Ans) Command:ls -l

Check the file size

```
student@616-B-8:~$ ls -l
total 44
drwxr-xr-x 3 student student 4096 Sep 16 10:52 Desktop
drwxr-xr-x 2 student student 4096 Aug 16 22:18 Documents
drwxr-xr-x 3 student student 4096 Aug 18 14:28 Downloads
-rw-rw-r-- 2 student student   45 Sep 25 09:32 file1.txt
-rw-rw-r-- 1 student student    0 Sep 21 12:23 file2.txt
-rw-rw-r-- 1 student student    0 Sep 21 12:23 file3.txt
-rw-rw-r-- 1 student student    0 Sep 21 12:23 file4.txt
-rw-rw-r-- 1 student student    0 Sep 21 12:23 file5.txt
-rw-rw-r-- 2 student student   45 Sep 25 09:32 link_file1
drwxr-xr-x 2 student student 4096 Aug 16 22:18 Music
drwxr-xr-x 3 student student 4096 Sep 11 10:51 Pictures
drwxr-xr-x 2 student student 4096 Aug 16 22:18 Public
drwx------ 4 student student 4096 Aug 18 14:28 snap
drwxr-xr-x 2 student student 4096 Aug 16 22:18 Templates
drwxr-xr-x 2 student student 4096 Aug 16 22:18 Videos
```

7)	Check the content of both the files and write your observation.
Ans)	Command:cat file1.txt Cat link_file1 Display the content of files.
	Delete the existing file on which you have created the link.
Ans)	Command:rm file1.txt Delete the file `student@616-B-8:~$ rm file1.txt`
9)	Apply ls –l and observer the output.

Ans)	Command:ls -l
	See the file size
	`student@616-B-8:~$ cat file1.txt`
	`My name is Aryaan.`
	`My Student id is 21CE112.`
	`student@616-B-8:~$ cat link_file1`
	`My name is Aryaan.`
	`My Student id is 21CE112.`

10)	Perform exercise 2 to 9 for creation of soft link and write your observation. (ln –s [original file] [link name])
Ans)	Command:ls -l gedit f1.txt ln -s f1.txt link_f 1 ls -l create a soft link and perform all task
11)	Write difference between hard link and soft link.
Ans)	**Hard Link:** A hard link is a reference to the same inode (data structure) as the original file, essentially creating multiple directory entries for the same data. **Soft Link (Symbolic Link):** A soft link, also known as a symbolic link or symlink, is a separate file that contains the path to the target file or directory. It acts as a pointer.

	File Systems, Storage, and Block Devices
12)	Apply ls –l /dev/sda1

Ans)	Command:ls -l /dev/sda1
	List details of a specified block device.
	`student@616-B-8:~/cspit/pendrive$ ls -l /dev/sda1`
	`brw-rw---- 1 root disk 8, 1 Sep 25 09:12 /dev/sda1`

13)	To get an overview of local and remote file system devices and the amount of free space available, run the df command

	`student@616-B-8:~/cspit$ ls -l`
	`total 0`
	`-rw-rw-r-- 1 student student 0 Sep 25 10:17 f1.txt`
	`lrwxrwxrwx 1 student student 6 Sep 25 10:17 link_f1 -> f1.txt`

Practical-6

1.	Check whether the given file exists or not.

```
vismit@Vismit:~$ ./pr6.sh
Enter file name :
file3.sh
File exists
```

Open pr6.sh ~/

```
1 echo "Enter file name : "
2 read file
3
4 if [ -f "$file" ]; then
5         echo "File exists"
6 else echo "File does not exists"
7 fi
```

2.	Check whether the argument passed from command line is file or directory.

```
vismit@Vismit:~$ ./pr62.sh
 Enter file
file3.sh
It is file
vismit@Vismit:~$ ./pr62.sh
 Enter file
Music
It is directory
```

```
1  echo " Enter file"
2  read file
3
4  if [ -f "$file" ]; then
5          echo "It is file"
6
7  elif [ -d "$file" ]; then
8          echo "It is directory"
9
10 else
11         echo "Entered does not exists"
12
13 fi
```

3. List out all empty files in current working directory. Directory may contain subdirectories also.

```
vismit@Vismit:~$ find . -empty
./Downloads
./Templates
./.ssh
./Desktop
./.config/nautilus
./.config/goa-1.0
./.config/.gsd-keyboard.settings-ported
./.config/gnome-session/saved-session
./.config/update-notifier
./.config/enchant/en.exc
./.config/enchant/en.dic
./.cache/evolution/addressbook/trash
./.cache/evolution/tasks/trash
./.cache/evolution/memos/trash
./.cache/evolution/sources/trash
./.cache/evolution/calendar/trash
./.cache/evolution/mail/trash
./.cache/ibus-table
./.cache/tracker3/files/.meta.isrunning
./.cache/tracker3/files/errors
./snap/snapd-desktop-integration/49/.local/share/glib-2.0/schemas
./snap/snapd-desktop-integration/49/.local/share/icons
./snap/snapd-desktop-integration/83/.local/share/glib-2.0/schemas
./snap/snapd-desktop-integration/83/.local/share/icons
./Documents
./Videos
./Pictures
```

```
./Pictures
./Music
./.local/share/nautilus/scripts
./.local/share/nautilus/tracker2-migration-complete
./.local/share/evolution/addressbook/trash
./.local/share/evolution/addressbook/system/photos
./.local/share/evolution/tasks/trash
./.local/share/evolution/memos/trash
./.local/share/evolution/calendar/trash
./.local/share/evolution/mail/trash
./.local/share/sounds
./.local/share/ibus-table
./.local/share/gnome-shell/gnome-overrides-migrated
./.local/share/flatpak/db
./.local/share/icc
./.local/share/gnome-settings-daemon/input-sources-converted
./.local/share/applications
./Public
```

4. Give two file names as command line arguments and check both the files are same or different. If they are same then delete the second file otherwise suggest why changes are required to make 1st file similar to second file.

Open demo642.sh ~/ Save

```
1 Hii everyone
```

Open *demo641.sh ~/ Save

```
1 Hello
2
```

Open pr64.sh ~/

```
1 if cmp $1 $2; then
2         echo "files are identical"
3 else
4         echo "files are diff"
5         diff $1 $2
6 fi
```

5. Print multiplication table of given number

Command: chmod +x multiply.sh

./multiply.sh

```
vismit@Vismit:~$ ./pr65.sh
Enter the number
6
6 * 1 = 6
6 * 2 = 12
6 * 3 = 18
6 * 4 = 24
6 * 5 = 30
6 * 6 = 36
6 * 7 = 42
6 * 8 = 48
6 * 9 = 54
6 * 10 = 60
```

Open pr65.sh ~/

```
1 echo "Enter the number"
2 read n
3
4 i = 1
5
6 while [ $i -le 10 ]
7 do
8 res=`expr $i \* $n`
9
10 echo "$n * $i = $res"
11
12 ((++i))
13
14 done
```

6. Shell script to check executable rights for all files in the current directory, if a file does not have the execute permission then make it executable.

```
vismit@Vismit:~$ ls -l
total 84
-rwxrwxr-x 1 vismit vismit    7 Aug 16 21:17 demo641.sh
-rwxrwxr-x 1 vismit vismit   13 Aug 16 21:17 demo642.sh
drwxr-xr-x 2 vismit vismit 4096 Jul 30 23:05 Desktop
drwxr-xr-x 2 vismit vismit 4096 Jul 30 23:05 Documents
drwxr-xr-x 2 vismit vismit 4096 Jul 30 23:05 Downloads
-rwxrwxr-x 1 vismit vismit   13 Aug  1 10:59 file1.sh
-rwxrwxr-x 1 vismit vismit   14 Aug  1 11:00 file2.sh
-rwxrwxr-x 1 vismit vismit  117 Aug  1 11:11 file3.sh
drwxr-xr-x 2 vismit vismit 4096 Jul 30 23:05 Music
drwxr-xr-x 3 vismit vismit 4096 Aug  8 09:46 Pictures
-rwxrwxr-x 1 vismit vismit  116 Aug  1 10:55 pr1.sh
-rwxrwxr-x 1 vismit vismit  171 Aug  8 10:33 pr62.sh
-rwxrwxr-x 1 vismit vismit   90 Aug 16 21:19 pr64.sh
-rwxrwxr-x 1 vismit vismit  118 Aug 16 21:26 pr65.sh
-rwxrwxr-x 1 vismit vismit  117 Aug  8 10:01 pr6.sh
drwxr-xr-x 2 vismit vismit 4096 Jul 30 23:05 Public
drwx------ 3 vismit vismit 4096 Jul 30 23:06 snap
drwxr-xr-x 2 vismit vismit 4096 Jul 30 23:05 Templates
-rwxrwxr-x 1 vismit vismit  194 Aug  1 10:10 text.sh
-rw-rw-r-- 1 vismit vismit   16 Aug  1 09:45 text.txt
drwxr-xr-x 2 vismit vismit 4096 Jul 30 23:05 Videos
```

7. Write a shell script for arithmetic calculator using command line arguments.

```
vismit@Vismit:~$ chmod +x  pr66.sh
vismit@Vismit:~$ ./pr66.sh
Enter two numbers :
8 1
1
Enter choice :
1.Add
2.Sub
3.Mul
4.Div
2
(standard_in) 1: syntax error
Result :
vismit@Vismit:~$ ./pr66.sh
Enter two numbers :
68
61
Enter choice :
1.Add
2.Sub
3.Mul
4.Div
1
Result : 129
```

Open pr66.sh ~/ Save

```
1 echo "Enter two numbers : "
2 read a
3 read b
4
5 #Input type of operation
6 echo "Enter choice : "
7 echo "1.Add"
8 echo "2.Sub"
9 echo "3.Mul"
10 echo "4.Div"
11 read ch
12
13 case $ch in
14         1)res=`echo $a + $b | bc`
15         ;;
16         2)res=`echo $a - $b | bc`
17         ;;
18         3)res=`echo $a \ * $b | bc`
19         ;;
20         4)res=`echo "scale=2; $a / $b" | bc`
21         ;;
22 esac
23 echo "Result : $res"
```

8. Write a script to print a given number in reversed order.

```
vismit@Vismit:~$ ./pr68.sh
enter n
68
number is 86
```

Open pr68.sh ~/ Save

```
1 echo enter n
2 read n
3 num=0
4 while [ $n -gt 0 ]
5 do
6 num=$(expr $num \* 10)
7 k=$(expr $n % 10)
8 num=$(expr $num + $k)
9 n=$(expr $n / 10)
10 done
11 echo number is $num
```

9.Write a script to convert string from lower to upper and upper to lower Case.

```
vismit@Vismit:~$ name='suhani'
vismit@Vismit:~$ echo $name
suhani
vismit@Vismit:~$ echo ${name^}
Suhani
vismit@Vismit:~$ echo ${name^^}
SUHANI
```

10. Shell script to Create a menu as shown below using the case statement

```
while true; do
    clear
    echo "Menu:"
    echo "1) List of files"
    echo "2) Today's date"
    echo "3) Users of system"
    echo "4) Processes of user"
    echo "5) Display process information (CPU utilization)"
    echo "6) Display run-level"
    echo "7) Exit"

    read -p "Enter your choice: " choice

    case $choice in
        1)
            ls -l
            read -p "Press enter to continue..."
            ;;
        2)
            date
```

```
        read -p "Press enter to continue..."
        ;;
    3)
        who
        read -p "Press enter to continue..."
        ;;
    4)
        echo "Enter the username:"
        read username
        ps -U $username
        read -p "Press enter to continue..."
        ;;
    5)
        top
        read -p "Press enter to continue..."
        ;;
    6)
        runlevel
        read -p "Press enter to continue..."
        ;;
    7)
        echo "Exiting..."
        exit 0
        ;;
    *)
        echo "Invalid choice. Please select a valid option."
        read -p "Press enter to continue..."
        ;;
  esac
done
```

11. Write a shell script to perform Memory allocation algorithms and calculate Internal and External Fragmentation. (First Fit, Best Fit, Worst Fit)

Conclusion : From these exercises, we learned about the commands used in ubuntu operating system. We got to know about the shell script commands in ubuntu and how all the files are created, viewed, checked if the file exist or not and much more.

Practical – 7

Part - A

AIM: The demonstration of fork () system call.

1) Ex1

Code:

```
#include <stdio.h>
#include <stdlib.h>
#include <sys/types.h>
#include <sys/wait.h>
#include <unistd.h>
int main(void)
{
    pid_t pid=fork();
    if(pid==0)
    {
            printf("Child => PPID: %d PID: %d\n",getppid(),getpid());
            exit(EXIT_SUCCESS);
    }
    else if(pid>0)
    {
            printf("Parent => PID: %d\n",getpid());
            printf("Waiting for child process to finish.\n");
            wait(NULL);
            printf("Child process finished.\n");
    }
    else

    {
            printf("Unable to create child process.\n");
    }
    return EXIT_SUCCESS;
}
```

Output:

```
Parent => PID: 1889
Waiting for child process to finish.
Child => PPID: 1889 PID: 1890
Child process finished.
```

2) Ex2

Code:

```
#include <stdio.h>
#include <sys/types.h>
#include <unistd.h>
int main()
{
    fork();
    printf("Hello world!\n");
    return 0;
}
```

Output:

```
Hello world!
```

3) Ex3

Code:

```
#include <stdio.h>
#include <sys/types.h>
int main()
{
    fork();
    fork();
    fork();
    printf("hello\n");
    return 0;
```

```
}
```

Output:

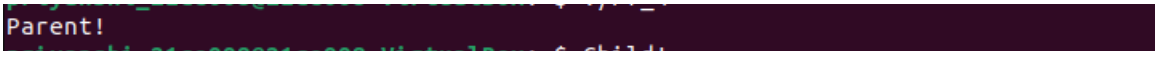
4) Ex4

Code:

```
#include <stdio.h>
#include <sys/types.h>
#include <unistd.h>
void forkexample()
{
    // child process because return value zero
    if (fork() == 0)
            printf("Child!\n");
    // parent process because return value non-zero.
    else
            printf("Parent!\n");
}

int main()
{
    forkexample();
    return 0;
}
```

Output:



Part - B

AIM: Demonstration of execve () and wait () system calls along with zombie and orphan states.

1) Zombie state (process)

Code:

```
#include <stdlib.h>
#include <sys/types.h>
#include <unistd.h>
#include <stdio.h>
int main()
{
 // Fork returns process id
 // in parent process
 pid_t child_pid = fork();

 // Parent process
 if (child_pid > 0)
 {
        sleep(10);
        printf("10 seconds waited..");
 }
 else
 exit(0);

 return 0;
}
```

Output:

```
irtualBox:~$ gedit P7_1b.c
irtualBox:~$ gcc P7_1b.c -o P7_1b
irtualBox:~$ ./P7_1b
```

2) Orphan state (process)

Code:

```
#include<stdio.h>
#include <sys/types.h>
#include <unistd.h>

int main()
{
```

```
// Create a child process
int pid = fork();

if (pid > 0)
printf("in parent process \n");

// Note that pid is 0 in child process
// and negative if fork() fails
else if (pid == 0)
{
sleep(5);
printf("in child process \n");
}

return 0;
}
```

Output:

```
irtualBox:~$ gedit orphan.c
irtualBox:~$ gcc orphan.c -o orphan
irtualBox:~$ ./orphan
21ce008@21ce008-VirtualBox:~$
```

3) Merge-Quick sort (use of execve() and wait())

Code:

/*Implement the C program in which main program accepts the integers to be sorted Main program uses the fork system call to create a new process called a child process.Parent process sorts the integers using merge sort and waits for child process using wait system call to sort the integers using quick sort.Also demonstrate zombie and orphan states. */

```
# include<stdio.h>
# include <stdlib.h>
# include<sys/types.h>
# include<unistd.h>
```

```
int split ( int[], int , int );
void quickSort(int* ,int, int);

void mergeSort(int arr[],int low,int mid,int high)
{
 int i,j,k,l,b[20];
 l=low;
 i=low;
 j=mid+1;
 while((l<=mid)&&(j<=high)){
        if(arr[l]<=arr[j])
        {
                b[i]=arr[l];
                l++;
        }
        else
        {
                b[i]=arr[j];
                j++;
        }
        i++;
 }

 if(l>mid)
 {
        for(k=j;k<=high;k++)
        {
                b[i]=arr[k];
                i++;
        }
 }
 else
 {
        for(k=l;k<=mid;k++)
        {
                b[i]=arr[k];
                i++;
```

```
        }
 }

for(k=low;k<=high;k++)
 {
        arr[k]=b[k];
 }
}

void partition(int arr[],int low,int high)
{
        int mid;
        if(low<high)
        {
                double temp;
                mid=(low+high)/2;
                partition(arr,low,mid);
                partition(arr,mid+1,high);
                mergeSort(arr,low,mid,high);
        }
}

 void display(int a[],int size)
 {
        int i;
        for(i=0;i<size;i++){
                printf("%d\t\t",a[i]);
        }
        printf("\n");
 }

 int main()
 {
        int pid, child_pid;
        int size,i,status;

        /* Input the Integers to be sorted */
        printf("Enter the number of Integers to Sort::::\t");
```

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

        int a[size];
        int pArr[size];
        int cArr[size];
        for(i=0;i<size;i++){
                printf("Enter number %d:",(i+1));
                scanf("%d",&a[i]);
                pArr[i]=a[i];
                cArr[i]=a[i];
        }


        /* Display the Enterd Integers */
        printf("Your Entered Integers for Sorting\n");
        display(a,size);

        /* Process ID of the Parent */
        pid=getpid();
        printf("Current Process ID is : %d\n",pid);
        /* Child Process Creation */
        printf("[ Forking Child Process ... ] \n");
        child_pid=fork(); /* This will Create Child Process and
        Returns Child's PID */
        if( child_pid < 0){
                /* Process Creation Failed ... */
                printf("\nChild Process Creation Failed!!!!\n");
                exit(-1);
        }
        else if( child_pid==0) {
                /* Child Process */
                printf("\nThe Child Process\n");
                printf("\nchild process is %d",getpid());
                printf("\nparent of child process is %d",getppid());
                printf("Child is sorting the list of Integers by QUICK
SORT::\n");
                quickSort(cArr,0,size-1);
                printf("The sorted List by Child::\n");
```

```
                display(cArr,size);
                printf("Child Process Completed ...\n");
                sleep(10);
                printf("\nparent of child process is %d",getppid());
        }
        else {
                /* Parent Process */
                printf("parent process %d started\n",getpid());
                printf("Parent of parent is %d\n",getppid());
                sleep(30);
                printf("The Parent Process\n");
                printf("Parent %d is sorting the list of Integers by MERGE
SORT\n",pid);
                partition(pArr,0,size-1);
                printf("The sorted List by Parent::\n");
                display(pArr,size);
                wait(&status);
                printf("Parent Process Completed ...\n");
        }
 return 0;
}

int split ( int a[ ], int lower, int upper )
{
        int i, p, q, t ;
        p = lower + 1 ;
        q = upper ;
        i = a[lower] ;
        while ( q >= p )
        {
                while ( a[p] < i )
                p++ ;
                while ( a[q] > i )
                q-- ;
                if ( q > p )
                {
                        t = a[p] ;
                        a[p] = a[q] ;
```

```
                        a[q] = t ;
                }
        }
        t = a[lower] ;
        a[lower] = a[q] ;
        a[q] = t ;
        return q ;
}

void quickSort(int a[],int lower, int upper){
 int i ;
 if ( upper > lower )
 {
        i = split ( a, lower, upper ) ;
        quickSort ( a, lower, i - 1 ) ;
        quickSort ( a, i + 1, upper ) ;
 }
}
```

Output:

```
Enter the number of Integers to Sort::::        2 6 4 3
Enter number 1:Enter number 2:Your Entered Integers for Sorting
6               4
Current Process ID is : 3341
[ Forking Child Process ... ]
parent process 3341 started
Parent of parent is 1881

The Child Process

child process is 3342
parent of child process is 3341Child is sorting the list of Integers by QUICK SORT::
The sorted List by Child::
4               6
Child Process Completed ...

parent of child process is 3341The Parent Process
Parent 3341 is sorting the list of Integers by MERGE SORT
The sorted List by Parent::
4               6
Parent Process Completed ...
```

4) Sort-Search (Parent-child process)

Code:

main

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

```
#include <stdlib.h>
#include <unistd.h>
#include <string.h>
int main(int argc, char *argv[])
{
        int val[10],ele;
        pid_t pid;
        char* cval[10];
        char *newenviron[] = { NULL };
        int i,j,n,temp;
        printf("\nEnter the size for an array: ");
        scanf("%d",&n);
        printf("\nEnter %d elements : ", n);
        for(i=0;i<n;i++)
                scanf("%d",&val[i]);

        printf("\nEntered elements are: ");
        for(i=0;i<n;i++)
                printf("\t%d",val[i]);
        for(i=1;i<n;i++)
        {
                for(j=0;j<n-1;j++)
                {
                        if(val[j]>val[j+1])
                        {
                                temp=val[j];
                                val[j]=val[j+1];
                                val[j+1]=temp;
                        }
                }
        }
        printf("\nSorted elements are: ");
        for(i=0;i<n;i++)
                printf("\t%d",val[i]);
        printf("\nEnter element to search: ");
        scanf("%d",&ele);
        val[i] = ele;
        for (i=0; i < n+1; i++)
```

```
        {
                char a[sizeof(int)];
                snprintf(a, sizeof(int), "%d", val[i]);
                cval[i] = malloc(sizeof(a));
                strcpy(cval[i], a);
        }
        cval[i]=NULL;

        pid=fork();
        if(pid==0)
        {
                char *child_executable = "./Child";  // Update the path if
needed

                execve(child_executable, cval, newenviron);
                perror("Error in execve call...");
        }
}
```

Child

```
#include <stdio.h>
#include <stdlib.h>
#include <string.h>
int main(int argc, char *argv[],char *en[])
{
        int i,j,c,ele;
        int arr[argc];

        for (j = 0; j < argc-1; j++)
        {
                int n=atoi(argv[j]);
                arr[j]=n;
        }
        ele=atoi(argv[j]);
        i=0;
        j=argc-1;
        c=(i+j)/2;
```

```
        while(arr[c]!=ele && i<=j)
        {
                if(ele > arr[c])
                i = c+1;
                else
                j = c-1;
                c = (i+j)/2;
        }
        if(i<=j)
                printf("\nElement Found in the given Array...!!!\n");
        else
                printf("\nElement Not Found in the given Array...!!!\n");
}
```

Output:

```
Enter the size for an array: 3

Enter 3 elements : 2 1 3

Entered elements are:   2       1       3
Sorted elements are:    1       2       3
Enter element to search: 1
```

5) Execvparent and execvchild

Code:

execvParent

```
#include<stdio.h>
#include<unistd.h>
#include<stdlib.h>
int main(int argc, char *argv[]){
        printf("\n-> PID of parent.c = %d ",getpid());
        int parent;
        parent = fork();
        if(parent == -1)
        {
                printf("\n-> Some errors in calling ");
        }
```

```
        if(parent == 0)
        {
                printf("\n-> The child process is running.");
                printf("\n-> Now execv will call child.c from child process.");
                char *args[]={"239",NULL};
                execv("./execvchild",args);
        }
        else{
                printf("\n-> Now parent is running \n");
        }
        return 0;
}
```

execvChild

```
#include<stdio.h>
#include<unistd.h>
#include<stdlib.h>
int main(int argc,char *argv[]){
        printf("\n-> Now we are in child.c");
        printf("\n-> The PID of child .c = %d",getpid());
        printf("\n-> %s",*argv);
        return 0;
}
```

Output:

```
-> PID of parent.c = 3636
-> Now parent is running
```

Practical-8

AIM:-

Implementation of Process Scheduling Algorithm:
a. FCFS
b. Round Robing
c. SJF
d. Priority Scheduling

Sr. No.	Code

8.1	**FCFS**
	Code:-
	`#include <iostream>`
	`#include <vector>`
	
	`using namespace std;`
	
	`void FCFS(vector<int> arrivalTime, vector<int> burstTime)`
	`{`
	`  int n = arrivalTime.size();`
	`  int completionTime[n], waitingTime[n], turnaroundTime[n];`
	
	`  // Calculate completion, waiting, and turnaround times`
	`  completionTime[0] = burstTime[0];`
	`  waitingTime[0] = 0;`
	`  turnaroundTime[0] = completionTime[0] - arrivalTime[0];`
	
	`  for (int i = 1; i < n; i++)`
	`  {`
	`  completionTime[i] = completionTime[i - 1] + burstTime[i];`
	`  waitingTime[i] = completionTime[i - 1] - arrivalTime[i];`

```
        turnaroundTime[i] = completionTime[i] - arrivalTime[i];
    }

    // Display results
    cout << "Process\tArrival Time\tBurst Time\tCompletion Time\tWaiting
Time\tTurnaround Time\n";
    for (int i = 0; i < n; i++)
    {
        cout << i + 1 << "\t" << arrivalTime[i] << "\t\t" << burstTime[i] << "\t\t" <<
completionTime[i] << "\t\t"
             << waitingTime[i] << "\t\t" << turnaroundTime[i] << "\n";
    }
}

int main()
{
    vector<int> arrivalTime = {0, 1, 2, 3};
    vector<int> burstTime = {5, 3, 8, 6};

    cout << "FCFS Scheduling:\n";
    FCFS(arrivalTime, burstTime);

    return 0;
}
```

Output:-

```
FCFS Scheduling:
Process Arrival Time    Burst Time      Completion Time Waiting Time    Turnaround Time
1       0               5               5               0               5
2       1               3               8               4               7
3       2               8               16              6               14
4       3               6               22              13              19
```

8.2 **Round Robin**

Code:-

```cpp
#include <iostream>
#include <vector>
#include <queue>

using namespace std;

struct Process
{
   int processID;
   int burstTime;
};

void roundRobin(vector<int> arrivalTime, vector<int> burstTime, int quantum)
{
   int n = arrivalTime.size();
   queue<Process> readyQueue;
   vector<int> remainingBurstTime(burstTime.begin(), burstTime.end());
   vector<int> completionTime(n, 0); // Initialize completion time to 0 for all processes

   int currentTime = 0;
   int completed = 0;
   int timeQuantum = quantum;
   int waitingTime[n], turnaroundTime[n];

   // Enqueue the first process
   readyQueue.push({0, burstTime[0]});

   // Simulate the Round Robin scheduling
   while (completed < n)
   {
      Process currentProcess = readyQueue.front();
      readyQueue.pop();

      if (remainingBurstTime[currentProcess.processID] <= timeQuantum)
      {
         currentTime += remainingBurstTime[currentProcess.processID];
         timeQuantum = remainingBurstTime[currentProcess.processID];
```

```
            remainingBurstTime[currentProcess.processID] = 0;
            completed++;

            // Set completion time for this process
            completionTime[currentProcess.processID] = currentTime;
        }
        else
        {
            currentTime += timeQuantum;
            remainingBurstTime[currentProcess.processID] -= timeQuantum;
        }

        // Enqueue the processes that arrive in the meantime
        for (int i = 0; i < n; i++)
        {
            if (arrivalTime[i] <= currentTime && remainingBurstTime[i] > 0)
            {
                readyQueue.push({i, remainingBurstTime[i]});
            }
        }

        // Enqueue the current process again if it's not completed
        if (remainingBurstTime[currentProcess.processID] > 0)
        {
            readyQueue.push(currentProcess);
        }

        // Calculate waiting and turnaround times
        waitingTime[currentProcess.processID] = currentTime -
burstTime[currentProcess.processID];
        turnaroundTime[currentProcess.processID] = waitingTime[currentProcess.processID]
+ burstTime[currentProcess.processID];
    }

    // Display results
    cout << "Process\tArrival Time\tBurst Time\tCompletion Time\tWaiting
Time\tTurnaround Time\n";
```

```
    for (int i = 0; i < n; i++)
    {
        cout << i + 1 << "\t" << arrivalTime[i] << "\t\t" << burstTime[i] << "\t\t" <<
completionTime[i] << "\t\t"
             << waitingTime[i] << "\t\t" << turnaroundTime[i] << "\n";
    }
}

int main()
{
    vector<int> arrivalTime = {0, 1, 2, 3};
    vector<int> burstTime = {5, 3, 8, 6};
    int quantum = 2;

    cout << "Round Robin Scheduling:\n";
    roundRobin(arrivalTime, burstTime, quantum);

    return 0;
}
```

Output:-

```
Round Robin Scheduling:
Process Arrival Time    Burst Time      Completion Time Waiting Time    Turnaround Time
1       0               5               9               4               9
2       1               3               0               6               9
3       2               8               0               1               9
4       3               6               0               3               9
```

8.3

SJF

Coode:-

```
#include <iostream>
#include <vector>
#include <algorithm>
```

```
using namespace std;

struct Process
{
   int processID;
   int arrivalTime;
   int burstTime;
};

bool compareBurstTime(const Process &a, const Process &b)
{
   return a.burstTime < b.burstTime;
}

void SJF(vector<int> arrivalTime, vector<int> burstTime)
{
   int n = arrivalTime.size();
   vector<Process> processes(n);

   for (int i = 0; i < n; i++)
   {
      processes[i].processID = i;
      processes[i].arrivalTime = arrivalTime[i];
      processes[i].burstTime = burstTime[i];
   }

   sort(processes.begin(), processes.end(), compareBurstTime);

   int completionTime[n], waitingTime[n], turnaroundTime[n];
   int currentTime = processes[0].arrivalTime;

   for (int i = 0; i < n; i++)
   {
      currentTime = max(currentTime, processes[i].arrivalTime);
      completionTime[processes[i].processID] = currentTime + processes[i].burstTime;
      waitingTime[processes[i].processID] = currentTime - processes[i].arrivalTime;
```

```
        turnaroundTime[processes[i].processID] = waitingTime[processes[i].processID] +
processes[i].burstTime;
        currentTime = completionTime[processes[i].processID];
    }

    // Display results
    cout << "Process\tArrival Time\tBurst Time\tCompletion Time\tWaiting
Time\tTurnaround Time\n";
    for (int i = 0; i < n; i++)
    {
        cout << processes[i].processID + 1 << "\t" << processes[i].arrivalTime << "\t\t" <<
processes[i].burstTime
             << "\t\t" << completionTime[processes[i].processID] << "\t\t" <<
waitingTime[processes[i].processID]
             << "\t\t" << turnaroundTime[processes[i].processID] << "\n";
    }
}

int main()
{
    vector<int> arrivalTime = {0, 1, 2, 3};
    vector<int> burstTime = {5, 3, 8, 6};

    cout << "SJF Scheduling:\n";
    SJF(arrivalTime, burstTime);

    return 0;
}
```

Output:-

```
SJF Scheduling:
Process Arrival Time    Burst Time      Completion Time Waiting Time    Turnaround Time
2       1               3               4               0               3
1       0               5               9               4               9
4       3               6               15              6               12
3       2               8               23              13              21
PS F:\Dansh\OS\Pr8> cd "e:\Dansh\OS\Pr8\" ; if ($?) { g++ Pr_8_4.cpp -o Pr_8_4 } ; if ($
```

8.4	**Prioriy Scheduling** **Code:-**

```
#include <iostream>
#include <vector>
#include <algorithm>

using namespace std;

struct Process
{
   int processID;
   int arrivalTime;
   int burstTime;
   int priority;
};

bool comparePriority(const Process &a, const Process &b)
{
   return a.priority < b.priority;
}

void priorityScheduling(vector<int> arrivalTime, vector<int> burstTime, vector<int>
priority)
{
   int n = arrivalTime.size();
   vector<Process> processes(n);

   for (int i = 0; i < n; i++)
   {
      processes[i].processID = i;
      processes[i].arrivalTime = arrivalTime[i];
      processes[i].burstTime = burstTime[i];
      processes[i].priority = priority[i];
   }
```

```
    sort(processes.begin(), processes.end(), comparePriority);

    int completionTime[n], waitingTime[n], turnaroundTime[n];
    int currentTime = processes[0].arrivalTime;

    for (int i = 0; i < n; i++)
    {
        currentTime = max(currentTime, processes[i].arrivalTime);
        completionTime[processes[i].processID] = currentTime + processes[i].burstTime;
        waitingTime[processes[i].processID] = currentTime - processes[i].arrivalTime;
        turnaroundTime[processes[i].processID] = waitingTime[processes[i].processID] +
processes[i].burstTime;
        currentTime = completionTime[processes[i].processID];
    }

    // Display results
    cout << "Process\tArrival Time\tBurst Time\tPriority\tCompletion Time\tWaiting
Time\tTurnaround Time\n";
    for (int i = 0; i < n; i++)
    {
        cout << processes[i].processID + 1 << "\t" << processes[i].arrivalTime << "\t\t" <<
processes[i].burstTime
             << "\t\t" << processes[i].priority << "\t\t" <<
completionTime[processes[i].processID] << "\t\t"
             << waitingTime[processes[i].processID] << "\t\t" <<
turnaroundTime[processes[i].processID] << "\n";
    }
}

int main()
{
    vector<int> arrivalTime = {0, 1, 2, 3};
    vector<int> burstTime = {5, 3, 8, 6};
    vector<int> priority = {2, 1, 3, 4};

    cout << "Priority Scheduling:\n";
    priorityScheduling(arrivalTime, burstTime, priority);
```

```
  return 0;
}
```

Output:-

```
Priority Scheduling:
Process Arrival Time    Burst Time      Priority        Completion Time Waiting Time    Turnaround Time
2       1               3               1               4               0               3
1       0               5               2               9               4               9
3       2               8               3               17              7               15
4       3               6               4               23              14              20
```

Practical 9 (A)

Aim:	Compare the Execution of single Process with threads execution.

THREAD
Threading is a light weight process which shares all the section of the process except for the stack. A process can have multiple threads.

Fork Vs Thread
While threads can execute in parallel with same context. Also, memory and other resources are
shared between the threads causing less overhead. A thread process is considered a sibling while
a forked process is considered a child. Also, threads are known as light-weight processes as they
don't have any overhead as compared to processes (as it doesn't issue any separate command for
creating completely new virtual address space). A single process can have multiple threads. For
all threads of any process, communication between them is direct. While process needs some interprocess communication mechanism to talk to other processes. Thought, threads seem to be
more useful for any reason, do note that changes in any thread may lead to changes in other threads of the same process. While, changes in child processes is independent as parent process
has its own execution copy.

Code:

```
#include <stdio.h>

#include <stdlib.h>

#include <pthread.h>

#define NO_OF_THREADS 5
#define ELEMENTS 100
static int arr[ELEMENTS];
static int sum;
int retval[5] = {
  1,
  2,
  3,
  4,
  5
};
int j = 0;
void * thread_sum(void * arg) {
```

```
  int i;
  int * current_thread_data = (int * ) arg;
  printf("-> Current thread no is : %d\n", current_thread_data[j]);
  int end = (current_thread_data[j]) * (ELEMENTS / NO_OF_THREADS);
  int start = end - (ELEMENTS / NO_OF_THREADS);
  printf("-> Here we will calculate the sum of %d to %d\n", arr[start], arr[end -
1]);
  int current_thread_sum = 0;
  for (i = start; i < end; i++) {
    current_thread_sum += arr[i];
  }
  sum += current_thread_sum;
  printf("-> current_thread_sum : %d\n", current_thread_sum);
  pthread_exit( & retval[j]);
  j++;
  return NULL;
}

int main() {
  int i, thread_no = 1;
  for (i = 0; i < ELEMENTS; i++)
    arr[i] = i + 1;
  pthread_t id[NO_OF_THREADS];
  int data_arr[NO_OF_THREADS];
  printf("-> Creating %d number of threads...\n", NO_OF_THREADS);
  for (thread_no = 1; thread_no <= NO_OF_THREADS; thread_no++) {
    data_arr[thread_no - 1] = thread_no;
    pthread_create( & id[thread_no - 1], NULL, thread_sum, &
data_arr[thread_no - 1]);
  }
  for (i = 1; i <= NO_OF_THREADS; i++)
    pthread_join(id[i - 1], NULL);
  printf("-> Total sum: %d\n", sum);
  return 0;
}
```

Output	PS D:\Program Files\OS\Pr9> cd "d:\Program Files\OS\Pr9\21CE068_Vismit\" Pr9.c -o Pr9 } ; if ($?) { .\Pr9 } -> Creating 5 number of threads... -> Current thread no is : 1 -> Here we will calculate the sum of 1 to 20 -> current_thread_sum : 210 -> Current thread no is : 2 -> Here we will calculate the sum of 21 to 40 -> current_thread_sum : 820 -> Current thread no is : 3 -> Here we will calculate the sum of 41 to 60 -> current_thread_sum : 1830 -> Current thread no is : 4 -> Here we will calculate the sum of 61 to 80 -> current_thread_sum : 3240 -> Current thread no is : 5 -> Here we will calculate the sum of 81 to 100 -> current_thread_sum : 5050 -> Total sum: 10150 PS D:\Program Files\OS\Pr9\21CE068_Vismit>
Questions:	Differentiate between fork and thread.
Answer:	Forking and threading are both mechanisms for achieving concurrent execution in computer programs, but they differ in fundamental ways. Forking involves creating a new independent process that duplicates the entire address space of the parent process, resulting in separate memory and execution contexts. Threads, on the other hand, are lighter-weight units of execution that share the same memory space as the parent process but have their own stack and program counter, allowing them to execute concurrently. Threads are generally more efficient for achieving parallelism within a single process, as they have lower overhead compared to forking, which involves duplicating resources. However, forking is more suitable for achieving true process-level isolation when strong separation between tasks is required.

Practical 9 (B)

Aim:	Perform Thread synchronization using counting semaphores and mutual exclusion using mutex

Code	**B) Perform Thread synchronization using counting semaphores**
	#include<pthread.h>
	#include<stdio.h>
	#include<semaphore.h>
	#include<unistd.h>
	void *fun1();
	void *fun2();
	int shared=1; //shared variable
	sem_t s; //semaphore variable
	int main()
	{
	sem_init(&s,0,1); //initialize semaphore variable - 1st argument is address of variable, 2nd is
	number of processes sharing semaphore, 3rd argument is the initial value of semaphore
	variable
	pthread_t thread1, thread2;
	pthread_create(&thread1, NULL, fun1, NULL);
	pthread_create(&thread2, NULL, fun2, NULL);
	pthread_join(thread1, NULL);
	pthread_join(thread2,NULL);
	printf("Final value of shared is %d\n",shared); //prints the last updated value of shared
	variable
	}
	void *fun1()
	{
	int x;
	sem_wait(&s); //executes wait operation on s
	x=shared;//thread1 reads value of shared variable
	printf("Thread1 reads the value as %d\n",x);
	x++; //thread1 increments its value
	printf("Local updation by Thread1: %d\n",x);
	sleep(1); //thread1 is preempted by thread 2
	shared=x; //thread one updates the value of shared variable
	printf("Value of shared variable updated by Thread1 is: %d\n",shared);
	sem_post(&s);
	}
	void *fun2()
	{
	int y;

```
sem_wait(&s);
y=shared;//thread2 reads value of shared variable
printf("Thread2 reads the value as %d\n",y);
y--; //thread2 increments its value
printf("Local updation by Thread2: %d\n",y);
sleep(1); //thread2 is preempted by thread 1
shared=y; //thread2 updates the value of shared variable
printf("Value of shared variable updated by Thread2 is: %d\n",shared);
sem_post(&s);
}
```

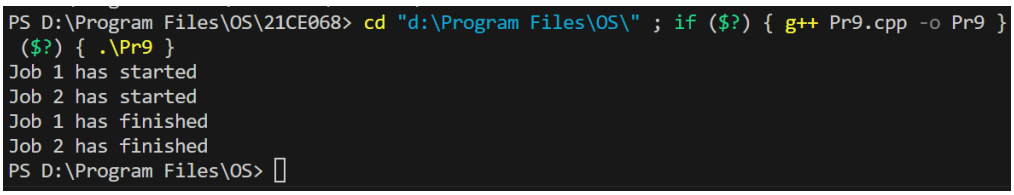
Output

```
PS D:\Program Files\OS\21CE068> cd "d:\Program Files\OS\" ; if ($?) { g++ Pr9.cpp -o Pr9 }
 ($?) { .\Pr9 }
Thread1 reads the value as 1
Local updation by Thread1: 2
Local updation by Thread2: 1
Value of shared variable updated by Thread2 is: 1
Value of shared variable updated by Thread1 is: 2
Final value of shared is 2
PS D:\Program Files\OS>
```

B) Perform Thread synchronization using mutex

An example code to study synchronization problems

```
#include <pthread.h>
#include <stdio.h>
#include <stdlib.h>
#include <string.h>
#include <unistd.h>
pthread_t tid[2];
int counter;
void* trythis(void* arg)
{
unsigned long i = 0;
counter +=7 1;
printf("\n Job %d has started\n", counter);
for (i = 0; i < (0xFFFFFFFF); i++) ;
printf("\n Job %d has finished\n", counter);
return NULL;
}
int main(void)
{
int i = 0;
int error;
while (i < 2) {
error = pthread_create(&(tid[i]), NULL, &trythis, NULL);
if (error != 0)
printf("\nThread can't be created : [%s]", strerror(error));
i++;
}
pthread_join(tid[0], NULL);
pthread_join(tid[1], NULL);
```

	return 0; }
Output	

	Practical 10
Aim:	Implement inter process communication (IPC) using PIPEs and FIFOs
Code:	**Using Pipes:**

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

int main() {
   int pipefds[2];
   int returnstatus;
   char writemessages[2][20]={"Hi", "Hello"};
   char readmessage[20];
   returnstatus = pipe(pipefds);

   if (returnstatus == -1) {
      printf("Unable to create pipe\n");
      return 1;
   }

   printf("Writing to pipe - Message 1 is %s\n",
writemessages[0]);
   write(pipefds[1], writemessages[0],
sizeof(writemessages[0]));
   read(pipefds[0], readmessage, sizeof(readmessage));
   printf("Reading from pipe – Message 1 is %s\n",
readmessage);
   printf("Writing to pipe - Message 2 is %s\n",
writemessages[0]);
   write(pipefds[1], writemessages[1],
sizeof(writemessages[0]));
   read(pipefds[0], readmessage, sizeof(readmessage));
   printf("Reading from pipe – Message 2 is %s\n",
readmessage);
   return 0;
}
```

Output:

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

Using FIFO

```
#include <iostream>
#include <cstdlib>
#include <cstring>
#include <unistd.h>
#include <sys/types.h>
#include <sys/stat.h>
#include <fcntl.h>

int main() {
    const char* fifo_path = "myfifo";

    // Create the FIFO if it doesn't exist
    if (mkfifo(fifo_path, 0666) == -1) {
        perror("mkfifo");
        exit(EXIT_FAILURE);
    }

    pid_t pid = fork();

    if (pid == -1) {
        perror("fork");
        exit(EXIT_FAILURE);
    }

    if (pid == 0) { // Child process
        int fifo_read = open(fifo_path, O_RDONLY);
        if (fifo_read == -1) {
            perror("open");
            exit(EXIT_FAILURE);
        }

        char buffer[100];
        ssize_t bytes_read = read(fifo_read, buffer,
sizeof(buffer));

        if (bytes_read == -1) {
            perror("read");
```

```
            exit(EXIT_FAILURE);
        }

        std::cout << "Child received: " <<
std::string(buffer, bytes_read) << std::endl;

        close(fifo_read);
    } else { // Parent process
        int fifo_write = open(fifo_path, O_WRONLY);
        if (fifo_write == -1) {
            perror("open");
            exit(EXIT_FAILURE);
        }

        std::string message = "Hello from parent";
        ssize_t bytes_written = write(fifo_write,
message.c_str(), message.size());

        if (bytes_written == -1) {
            perror("write");
            exit(EXIT_FAILURE);
        }

        close(fifo_write);
    }

    // Remove the FIFO file
    if (unlink(fifo_path) == -1) {
        perror("unlink");
        exit(EXIT_FAILURE);
    }

    return 0;
}
```

Output: