Lab Manual

Subject	OPERATING SYSTEM	
Submitted by	Muhammad Khubaib	23-st-017
Semester	Spring 2023 (4th Semester)	

Department of Software Engineering Technology

Lab 1 :Introduction to Linux

Objective:

The objective of this lab is to familiarize students with the Linux environment, including its history, architecture, shell usage, and basic commands.

1. Basic Linux History and Architecture

- Linux is an open-source operating system based on UNIX, developed by Linus Torvalds in 1991.
- It follows a monolithic kernel architecture, meaning that the entire OS runs in kernel mode, providing direct hardware access.
- The core components include:
    - **Kernel:** Manages hardware and system processes.
    - **Shell:** Interface between users and the kernel.
    - **File System:** Organizes data in a hierarchical structure.

3. Linux File System Hierarchy

- The Linux file system is structured as follows:
    - / - Root directory (everything starts here)
    - /home - User files and directories
    - /etc - System configuration files
    - /var - Variable data (logs, caches)
    - /bin - Essential system binaries
    - /usr - User-installed software

1. Navigate to the Home Directory and Create Lab1 Directory.

```
muhammad@DESKTOP-HA2PTL5:~$ cd ~
muhammad@DESKTOP-HA2PTL5:~$ mkdir lab1
muhammad@DESKTOP-HA2PTL5:~$ cd lab1
```

2. Check if the directory is created.

```
muhammad@DESKTOP-HA2PTL5:~/lab1$ ls -l
total 0
```

3. **Inside Lab1,Create a text File Named test.txt.**

```
muhammad@DESKTOP-HA2PTL5:~/lab1$ touch test.txt
```

Verify the file creation:

```
muhammad@DESKTOP-HA2PTL5:~/lab1$ ls -l
total 0
-rw-r--r-- 1 muhammad muhammad 0 Mar 20 18:07 test.txt
```

4. **Display System Information.**

```
muhammad@DESKTOP-HA2PTL5:~/lab1$ uname -a
Linux DESKTOP-HA2PTL5 5.15.167.4-microsoft-standard-WSL2 #
```

5. **Show Logged-in Users**

```
muhammad@DESKTOP-HA2PTL5:~/lab1$ who
muhammad pts/1        2025-03-20 17:54
```

6. **Print the Current Date.**

```
muhammad@DESKTOP-HA2PTL5:~/lab1$ date
Thu Mar 20 18:08:57 PKT 2025
```

7. **Clean Up (Optional).**

```
muhammad@DESKTOP-HA2PTL5:~/lab1$ rm test.txt
muhammad@DESKTOP-HA2PTL5:~/lab1$ cd ..
muhammad@DESKTOP-HA2PTL5:~$ rmdir lab1
muhammad@DESKTOP-HA2PTL5:~$
```

GENERALIZED LAB RUBRICS

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Lab 2: File and Directory Management

Objective:

- Gain proficiency in basic file and directory operations.
- Understand file permissions and ownership.
- Learn to locate files using the find command.

1. Create a dedicated directory for this lab to avoid cluttering your system.

```
muhammad@DESKTOP-HA2PTL5:~$ mkdir lab2
muhammad@DESKTOP-HA2PTL5:~$ cd lab2
```

2. File Manipulation Commands

➢ **Create a file:**

```
muhammad@DESKTOP-HA2PTL5:~/lab2$ touch file1.txt
```

➢ **Copy a file:**

```
muhammad@DESKTOP-HA2PTL5:~/lab2$ cp file1.txt file2.txt
```

➢ **Rename/Move a file:**

```
muhammad@DESKTOP-HA2PTL5:~/lab2$ mv file2.txt renamed_file.txt
```

➢ **Delete a file:**

```
muhammad@DESKTOP-HA2PTL5:~/lab2$ rm renamed_file.txt
```

3. Directory Commands

➢ **Create a directory:**

```
muhammad@DESKTOP-HA2PTL5:~/lab2$ mkdir mydir
```

➢ **Move a file into the directory:**

```
muhammad@DESKTOP-HA2PTL5:~/lab2$ mv file1.txt mydir/
```

➢ **Remove a directory and its contents:**

```
muhammad@DESKTOP-HA2PTL5:~/lab2$ rm -r mydir
```

4. File Permissions and Ownership

➢ **Check file permissions:**

```
muhammad@DESKTOP-HA2PTL5:~/lab2$ touch file3.txt
muhammad@DESKTOP-HA2PTL5:~/lab2$ ls -l file3.txt
-rw-r--r-- 1 muhammad muhammad 0 Mar 20 19:25 file3.txt
```

➢ **Change file permissions**

- **Give the owner execute permission:**

```
muhammad@DESKTOP-HA2PTL5:~/lab2$ chmod u+x file3.txt
```

- **Remove read permission for the group:**

```
muhammad@DESKTOP-HA2PTL5:~/lab2$ chmod g-r file3.txt
```

- **Change file ownership:**

```
muhammad@DESKTOP-HA2PTL5:~/lab2$ sudo chown root file3.t
xt
[sudo] password for muhammad:
Sorry, try again.
[sudo] password for muhammad:
```

5. Using find to locate file.

➢ **Create test files:**

```
muhammad@DESKTOP-HA2PTL5:~/lab2$ mkdir dir1 dir2
muhammad@DESKTOP-HA2PTL5:~/lab2$ touch dir1/file4.txt di
r2/file2.txt
```

➢ **Find files by name:**

```
muhammad@DESKTOP-HA2PTL5:~/lab2$ find . -name file4.txt
./dir1/file4.txt
```

➢ **Find files by type:**

```
muhammad@DESKTOP-HA2PTL5:~/lab2$ find . -type f -name "*.txt"
./file3.txt
./dir1/file4.txt
./dir2/file2.txt
```

➢ **Find files by modification time:**

```
muhammad@DESKTOP-HA2PTL5:~/lab2$ find . -mtime -1
.
./file3.txt
./dir1
./dir1/file4.txt
./dir2
```

6. Cleanup:

```
muhammad@DESKTOP-HA2PTL5:~/lab2$ cd ..
rm -r lab2ESKTOP-HA2PTL5:~/lab2$
rm: remove write-protected regular empty file 'lab2/file3.txt'?
rm: cannot remove 'lab2': Directory not empty
```

m

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Lab 3: Working with Text Files in Linux

Objective:

Learn how to manipulate and process text files using Linux commands.

1. Create a Directory for Lab 3

Before starting, create a dedicated directory:

```
muhammad@DESKTOP-HA2PTL5:~$ mkdir lab3
muhammad@DESKTOP-HA2PTL5:~$ cd lab3
```

2. Create and View Files

- **Create a Sample Text File:**

```
muhammad@DESKTOP-HA2PTL5:~/lab3$ nano sample.txt
```

- View File Contents:

```
muhammad@DESKTOP-HA2PTL5:~/lab3$ cat sample.txt

Muhammad Kubaib
23-st-017
Software Enginnering Technology
Linux Lab
Godd Lab
```

- **View file with pagination:**

```
muhammad@DESKTOP-HA2PTL5:~/lab3$ more sample.txt

Muhammad Kubaib
23-st-017
Software Enginnering Technology
Linux Lab
Godd Lab
muhammad@DESKTOP-HA2PTL5:~/lab3$ less sample.txt
```

- **View the first 2 lines and last 3 lines:**

```
muhammad@DESKTOP-HA2PTL5:~/lab3$ head -2 sample.txt

Muhammad Kubaib
muhammad@DESKTOP-HA2PTL5:~/lab3$ tail -3 sample.txt
Software Enginnering Technology
Linux Lab
Godd Lab
```

3. Edit Files

- **Use nano or vi to edit:**

```
muhammad@DESKTOP-HA2PTL5:~/lab3$ nano sample.txt
muhammad@DESKTOP-HA2PTL5:~/lab3$ echo sample.txt
sample.txt
```

```
muhammad@DESKTOP-HA2PTL5:~/lab3$ cat sample.txt

Lab3 Softwar
Jigger
Software Deployement
Muhammad Kubaib
23-st-017
Software Enginnering Technology
Linux Lab
Godd Lab
```

4. Search for Text Patterns

- **Find a Word in a File**

```
muhammad@DESKTOP-HA2PTL5:~/lab3$ grep "Linux" sample.txt
Linux Lab
```

- **Find a Word and Show Line Numbers**

```
muhammad@DESKTOP-HA2PTL5:~/lab3$ grep -n "Linux" sample.txt
8:Linux Lab
```

- **Case-Insensitive Search**

```
muhammad@DESKTOP-HA2PTL5:~/lab3$ grep -i "Muhammad" sample.txt
Muhammad Kubaib
```

- **Search for Lines That Do Not Contain a Word.**

```
muhammad@DESKTOP-HA2PTL5:~/lab3$ grep -v "Linux" sample.txt

Lab3 Softwar
Jigger
Software Deployement
Muhammad Kubaib
23-st-017
Software Enginnering Technology
Godd Lab
```

5. Combine and Split Files

- **Concatenate (Join) Multiple Files**

- **Create another file:**

```
muhammad@DESKTOP-HA2PTL5:~/lab3$ nano second.txt
```

- **Combine both files into a new file:**

```
muhammad@DESKTOP-HA2PTL5:~/lab3$ cat sample.txt second.txt > merged.txt
```

- **View the new file:**

```
muhammad@DESKTOP-HA2PTL5:~/lab3$ cat merged.txt

Lab3 Softwar
Jigger
Software Deployement
Muhammad Kubaib
23-st-017
Software Enginnering Technology
Linux Lab
Godd Lab
This is another text file.
```

➢ **Split a Large File**

- **To split a large file into smaller parts:**

```
muhammad@DESKTOP-HA2PTL5:~/lab3$ split -l 10 merged.txt part_
```

6. Delete a File or Directory

➢ **To remove a file:**

```
muhammad@DESKTOP-HA2PTL5:~$ cd lab3
muhammad@DESKTOP-HA2PTL5:~/lab3$ rm sample.txt
```

➢ **To remove a directory and all its contents:**

```
muhammad@DESKTOP-HA2PTL5:~$ sudo rm -rf lab3
[sudo] password for muhammad:
muhammad@DESKTOP-HA2PTL5:~$
```

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Lab 4: Managing Users and Groups in Linux

Objective:

Learn to create and manage users, assign groups, and control file permissions in Linux.

---

1. Create a New User

```
muhammad@DESKTOP-HA2PTL5:~$ sudo adduser newuser
info: Adding user `newuser' ...
info: Selecting UID/GID from range 1000 to 59999 ...
info: Adding new group `newuser' (1001) ...
info: Adding new user `newuser' (1001) with group `newuser (1001)' ...
warn: The home directory `/home/newuser' already exists.  Not touching this directory.
New password:
Retype new password:
passwd: password updated successfully
Changing the user information for newuser
Enter the new value, or press ENTER for the default
        Full Name []: Muhammad Khuabib
        Room Number []: 23-sT-017
        Work Phone []: 03037870373
        Home Phone []: 03036945963
        Other []: no
Is the information correct? [Y/n] y
info: Adding new user `newuser' to supplemental / extra groups `users' ...
info: Adding user `newuser' to group `users' ...
```

- **Verify the User Creation**

```
muhammad@DESKTOP-HA2PTL5:~$ id newuser
uid=1001(newuser) gid=1001(newuser) groups=1001(newuser),100(users)
```

---

2. Assign the User to a Group

- **Create a New Group and add user to group and verify Membership.**

```
muhammad@DESKTOP-HA2PTL5:~$ sudo groupadd testgroup
muhammad@DESKTOP-HA2PTL5:~$ sudo usermod -aG testgroup newuser
muhammad@DESKTOP-HA2PTL5:~$ groups newuser
newuser : newuser users testgroup
```

---

3. Switch to the New User

- **Log in as the newly created user and check username(newuser):**

```
muhammad@DESKTOP-HA2PTL5:~$ su - newuser
Password:
Welcome to Ubuntu 24.04.1 LTS (GNU/Linux 5.15.167.4-microsoft-standard-WSL2 x86_64)

 * Documentation:  https://help.ubuntu.com
 * Management:     https://landscape.canonical.com
 * Support:        https://ubuntu.com/pro

 System information as of Sat Mar 22 08:16:56 PKT 2025

  System load:  0.02               Processes:             31
  Usage of /:   0.2% of 1006.85GB  Users logged in:       1
  Memory usage: 10%                IPv4 address for eth0: 172.23.52.78
  Swap usage:   0%

 * Strictly confined Kubernetes makes edge and IoT secure. Learn how MicroK8s
   just raised the bar for easy, resilient and secure K8s cluster deployment.

   https://ubuntu.com/engage/secure-kubernetes-at-the-edge

This message is shown once a day. To disable it please create the
/home/newuser/.hushlogin file.
newuser@DESKTOP-HA2PTL5:~$ whoami
newuser
```

---

4. Test File Access with Different Permissions

- **Create a Test File**

```
newuser@DESKTOP-HA2PTL5:~$ touch testfile.txt
```

- **Check the file's permissions:**

```
newuser@DESKTOP-HA2PTL5:~$ ls -l testfile.txt
-r--r--r-- 1 newuser newuser 16 Mar 22 08:17 testfile.txt
```

- **Change File Permissions**

```
newuser@DESKTOP-HA2PTL5:~$ chmod 444 testfile.txt
```

- **Try modifying the file:**

```
newuser@DESKTOP-HA2PTL5:~$ echo "test" > testfile.txt
-bash: testfile.txt: Permission denied
```

- **Grant Write Access to the Group**

```
newuser@DESKTOP-HA2PTL5:~$ exit
logout
```

---

5. Delete the User and Group

- **Remove the User and Group and home directories:**

```
muhammad@DESKTOP-HA2PTL5:~$ sudo deluser newuser
info: Removing crontab ...
info: Removing user `newuser' ...
```

- **Remove the Group and Home Directory of the user:**

```
muhammad@DESKTOP-HA2PTL5:~$ sudo groupdel testgroup
muhammad@DESKTOP-HA2PTL5:~$ sudo rm -r /home/newuser
muhammad@DESKTOP-HA2PTL5:~$
```

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Domain	Component with Taxonomy	Above Expectation (4)	Meeting Expectation (3)	Approaching Expectation (2)	Below Expectation (1)	Used	Weight / 100 (Optional)	Score (1–4)
Affective	**Safety Instructions (PLO6)**	Assesses and complies with all EHS instructions while in lab	Assesses and complies with most EHS instructions while in lab	Assesses and complies with some EHS instructions while in lab	Assesses and complies with few EHS instructions in lab	☐		
	Professional Ethics (PLO8)	Exhibits exemplary professional ethics while writing lab reports and dealing with fellow students, lab staff and instructor all the time	Exhibits professional ethics while writing lab reports and dealing with fellow students, lab staff and instructor all the time	Makes an effort to exhibit professional ethics while writing lab reports and dealing with fellow students, lab staff and instructor all the time	Does not exhibit professional ethics while writing lab reports and dealing with fellow students, lab staff and instructor all the time	☐		
	Contribution (PLO9)	Consistently shows full preparation by completing all agreed tasks and provides additional resources for the group and work quality is excellent	Consistently shows full preparation by completing all agreed tasks and work requires little or no revisions	Shows some preparation which is mostly at superficial level in completing a task and work requires much revisions and editing	Shows very little or no preparation in completing a task and work quality is poor	☐		
	Attitude (PLO9)	Internalized positive behavior and encourages and helps other team members	Consistent positive behavior most of the time towards other team members	Neither helpful nor damaging and shows disinterest in the performance of others	Discouraging behavior towards other team members	☐		
	Report Writing (PLO10)	Report on all relevant sections related to the lab tasks is completed accurately, meeting the requirements, in prescribed time and with good language skills	Report on all relevant sections related to the lab tasks is completed but few deficiencies are present in terms of accuracy / meeting the requirements / prescribed time / good language skills	Report on all relevant sections related to the lab tasks is completed but many deficiencies are present in terms of accuracy / meeting the requirements / prescribed time / good language skills	Report on all relevant sections related to the lab tasks is not completed	☐		
	Lab Task Management (PLO11)	Manages tasks well within given timeframe	Manages tasks within given timeframe	Manages tasks in an extended timeframe	Does not manage tasks even in extended timeframes	☐		

Lab 5: Process Management in Linux

Objective:

Work with processes and understand system resources.

1. View Running Processes

- **List active processes:**

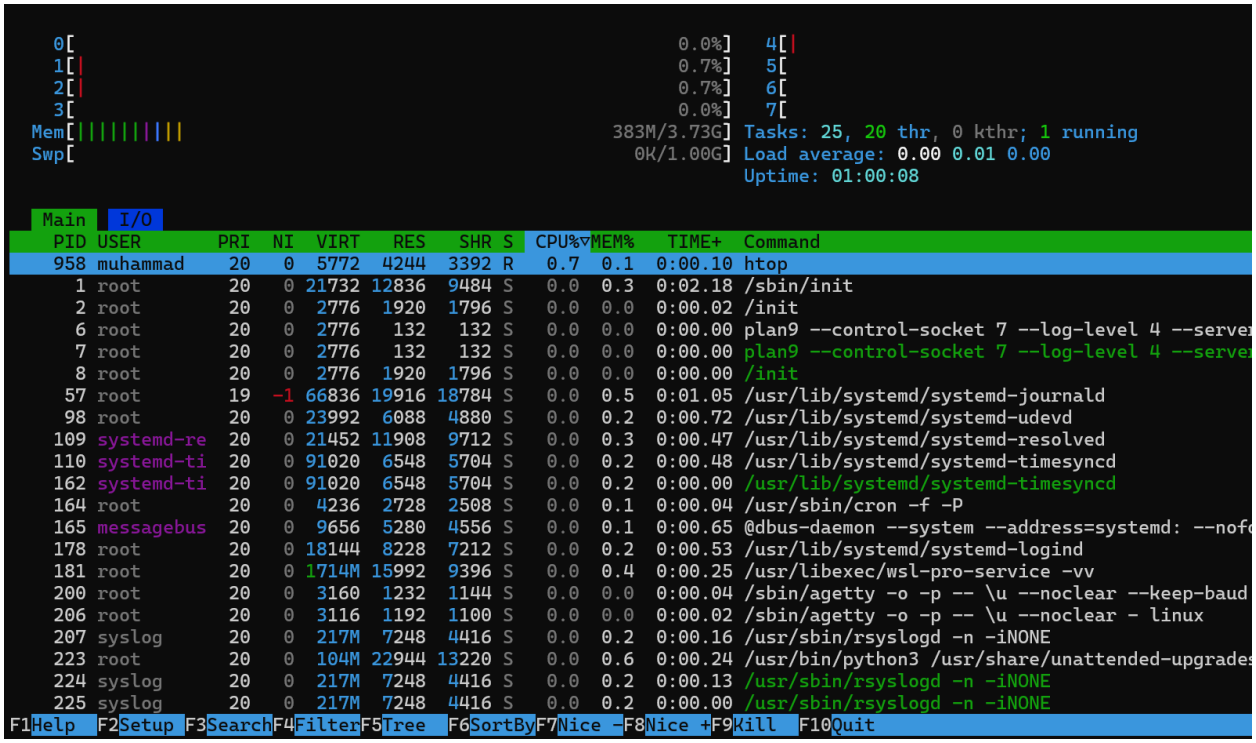
```
muhammad@DESKTOP-HA2PTL5:~$ mkdir lab5
muhammad@DESKTOP-HA2PTL5:~$ cd lab5
muhammad@DESKTOP-HA2PTL5:~/lab5$ ps aux
USER         PID %CPU %MEM    VSZ   RSS TTY      STAT START   TIME COMMAND
root           1  0.1  0.3  21732 12836 ?        Ss   08:13   0:01 /sbin/init
root           2  0.0  0.0   2776  1920 ?        Sl   08:13   0:00 /init
root           6  0.0  0.0   2776   132 ?        Sl   08:13   0:00 plan9 --control-socket 7 --log-level 4 --se
root          57  0.0  0.5  66836 19824 ?        S<s  08:13   0:00 /usr/lib/systemd/systemd-journald
root          98  0.0  0.1  23992  6088 ?        Ss   08:13   0:00 /usr/lib/systemd/systemd-udevd
systemd+     109  0.0  0.3  21452 11908 ?        Ss   08:13   0:00 /usr/lib/systemd/systemd-resolved
systemd+     110  0.0  0.1  91020  6548 ?        Ssl  08:13   0:00 /usr/lib/systemd/systemd-timesyncd
root         164  0.0  0.0   4236  2728 ?        Ss   08:13   0:00 /usr/sbin/cron -f -P
message+     165  0.0  0.1   9528  5188 ?        Ss   08:13   0:00 @dbus-daemon --system --address=systemd: --
root         178  0.0  0.2  18144  8228 ?        Ss   08:13   0:00 /usr/lib/systemd/systemd-logind
root         181  0.0  0.4 1756096 15992 ?       Ssl  08:13   0:00 /usr/libexec/wsl-pro-service -vv
root         200  0.0  0.0   3160  1232 hvc0     Ss+  08:13   0:00 /sbin/agetty -o -p -- \u --noclear --keep-b
root         206  0.0  0.0   3116  1192 tty1     Ss+  08:13   0:00 /sbin/agetty -o -p -- \u --noclear - linux
syslog       207  0.0  0.1 222508  7248 ?        Ssl  08:13   0:00 /usr/sbin/rsyslogd -n -iNONE
root         223  0.0  0.5 107012 22944 ?        Ssl  08:13   0:00 /usr/bin/python3 /usr/share/unattended-upgr
root         306  0.0  0.0   2784   204 ?        Ss   08:14   0:00 /init
root         308  0.0  0.0   2784   208 ?        S    08:14   0:00 /init
muhammad     316  0.0  0.1   6072  5228 pts/0    Ss   08:14   0:00 -bash
root         317  0.0  0.1   6688  4616 pts/1    Ss   08:14   0:00 /bin/login -f
muhammad     407  0.0  0.2  20256 11484 ?        Ss   08:14   0:00 /usr/lib/systemd/systemd --user
muhammad     408  0.0  0.0  21144  1724 ?        S    08:14   0:00 (sd-pam)
muhammad     426  0.0  0.1   6072  5296 pts/1    S+   08:14   0:00 -bash
muhammad     739 33.3  0.1   8280  4120 pts/0    R+   08:39   0:00 ps aux
```

- **Display real-time process monitoring:**

```
muhammad@DESKTOP-HA2PTL5:~/lab5$ top
top - 08:41:39 up 27 min,  1 user,  load average: 0.04, 0.02, 0.00
Tasks:  23 total,   1 running,  22 sleeping,   0 stopped,   0 zombie
%Cpu(s):  0.0 us,  0.0 sy,  0.0 ni,100.0 id,  0.0 wa,  0.0 hi,  0.0 si,  0.0 st
MiB Mem :   3822.0 total,   3338.5 free,    538.9 used,    117.7 buff/cache
MiB Swap:   1024.0 total,   1024.0 free,      0.0 used.   3283.1 avail Mem

    PID USER      PR  NI    VIRT    RES    SHR S  %CPU  %MEM     TIME+ COMMAND
    740 muhammad  20   0    9276   5220   3076 R   0.3   0.1   0:00.42 top
      1 root      20   0   21732  12836   9484 S   0.0   0.3   0:01.76 systemd
      2 root      20   0    2776   1920   1796 S   0.0   0.0   0:00.02 init-systemd(Ub
      6 root      20   0    2776    132    132 S   0.0   0.0   0:00.00 init
     57 root      19  -1   66836  19828  18696 S   0.0   0.5   0:00.76 systemd-journal
     98 root      20   0   23992   6088   4880 S   0.0   0.2   0:00.49 systemd-udevd
    109 systemd+  20   0   21452  11908   9712 S   0.0   0.3   0:00.43 systemd-resolve
    110 systemd+  20   0   91020   6548   5704 S   0.0   0.2   0:00.35 systemd-timesyn
    164 root      20   0    4236   2728   2508 S   0.0   0.1   0:00.02 cron
    165 message+  20   0    9528   5188   4556 S   0.0   0.1   0:00.35 dbus-daemon
```

- **Use an interactive process viewer (optional, if installed):**



2. Manage Processes

- **Start a process in the background and view background jobs and Bring a background job to the foreground and Send a stopped job to the background:**

```
muhammad@DESKTOP-HA2PTL5:~/lab5$ sleep 100 &
[1] 1005
muhammad@DESKTOP-HA2PTL5:~/lab5$ jobs
[1]+  Running                 sleep 100 &
muhammad@DESKTOP-HA2PTL5:~/lab5$ fg %1
sleep 100
^Z
[1]+  Stopped                 sleep 100
muhammad@DESKTOP-HA2PTL5:~/lab5$ bg %1
[1]+ sleep 100 &
```

- **Find the PID of a process and Kill a process using PID:**

```
muhammad@DESKTOP-HA2PTL5:~/lab5$ ps aux | grep sleep
muhammad    1005  0.0  0.0   3124  1064 pts/0    S    09:29   0:00 sleep 100
muhammad    1009  0.0  0.0   4088  1924 pts/0    S+   09:30   0:00 grep --color=auto sleep
muhammad@DESKTOP-HA2PTL5:~/lab5$ kill 1005
```

- **Kill a process by name:**

```
muhammad@DESKTOP-HA2PTL5:~/lab5$ pkill sleep
[1]+  Terminated              sleep 100
```

3. Adjust Process Priority

- **Start a process with a lower priority (higher nice value):**

```
muhammad@DESKTOP-HA2PTL5:~/lab5$ nice -n 10 sleep 300 &
[1] 1024
muhammad@DESKTOP-HA2PTL5:~/lab5$ pgrep sleep
1024
```

- **Change the priority of an existing process:**

```
muhammad@DESKTOP-HA2PTL5:~/lab5$ sudo renice -n 5 -p 1024
1024 (process ID) old priority 10, new priority 5
```

- **Verify process priority:**

```
muhammad@DESKTOP-HA2PTL5:~/lab5$ ps -o pid,ni,comm -p 1024
    PID  NI COMMAND
muhammad@DESKTOP-HA2PTL5:~/lab5$
```

4. Monitor System Resource Usage

- **Check CPU and memory usage:**

```
muhammad@DESKTOP-HA2PTL5:~/lab5$ vmstat 1 5
procs -----------memory---------- ---swap-- -----io---- -system-- -------cpu-------
 r  b   swpd   free   buff  cache   si   so    bi    bo   in   cs us sy id wa st gu
 1  0      0 3380788   2080 136520    0    0    98    25   18    0  0  0 100  0  0  0
 0  0      0 3380788   2080 136520    0    0     0     0   62  110  0  0 100  0  0  0
 0  0      0 3380788   2088 136512    0    0     0   112   10   51  0  0 99  1  0  0
 0  0      0 3380788   2088 136512    0    0     0     0    4   32  0  0 100  0  0  0
 0  0      0 3380788   2088 136512    0    0     0     0    3   30  0  0 100  0  0  0
```

- **Monitor disk I/O usage:**

```
muhammad@DESKTOP-HA2PTL5:~/lab5$  iostat
Linux 5.15.167.4-microsoft-standard-WSL2 (DESKTOP-HA2PTL5)      03/22/25        _x86_64_        (8 CPU)

avg-cpu:  %user   %nice %system %iowait  %steal   %idle
          0.06    0.00    0.10    0.07    0.00   99.77

Device             tps    kB_read/s    kB_wrtn/s    kB_dscd/s    kB_read    kB_wrtn    kB_dscd
sda               0.22        14.27         0.00         0.00      74557          0          0
sdb               0.02         0.43         0.00         0.00       2228          4          0
sdc               4.09       113.81        27.44        44.19     594677     143360     230904
```

- **Monitor memory usage:**

```
muhammad@DESKTOP-HA2PTL5:~/lab5$ free -h
               total        used        free      shared  buff/cache   available
Mem:           3.7Gi       592Mi       3.1Gi       3.2Mi       305Mi       3.2Gi
Swap:          1.0Gi          0B       1.0Gi
```

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Cognitive	**Recording Measurements** (Hardware / Software)	Is able to record accurate measurements all the time	Is able to record accurate measurements most of the time	Is only able to record accurate measurements on some occasions	Is unable to record accurate measurements	☐		
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	Software Usage (Software)	Is adept in the use of software tool and can access advanced features	Is able to use the software tool effectively by accessing all the required features	Is able to use the software tool but cannot access all the required features	Is unable to use the software tool	☐		
	Programming Language (Software)	Is able to efficiently complete a given task using advanced programming language constructs / methods / commands and/or add features to the original task	Is able to complete a given task using required programming language constructs / methods / commands	Is able to partially complete a given task	Is unable to partially complete a given task	☐		

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Affective	**Safety Instructions (PLO6)**	Assesses and complies with all EHS instructions while in lab	Assesses and complies with most EHS instructions while in lab	Assesses and complies with some EHS instructions while in lab	Assesses and complies with few EHS instructions in lab	☐		
	Professional Ethics (PLO8)	Exhibits exemplary professional ethics while writing lab reports and dealing with fellow students, lab staff and instructor all the time	Exhibits professional ethics while writing lab reports and dealing with fellow students, lab staff and instructor all the time	Makes an effort to exhibit professional ethics while writing lab reports and dealing with fellow students, lab staff and instructor all the time	Does not exhibit professional ethics while writing lab reports and dealing with fellow students, lab staff and instructor all the time	☐		
	Contribution (PLO9)	Consistently shows full preparation by completing all agreed tasks and provides additional resources for the group and work quality is excellent	Consistently shows full preparation by completing all agreed tasks and work requires little or no revisions	Shows some preparation which is mostly at superficial level in completing a task and work requires much revisions and editing	Shows very little or no preparation in completing a task and work quality is poor	☐		
	Attitude (PLO9)	Internalized positive behavior and encourages and helps other team members	Consistent positive behavior most of the time towards other team members	Neither helpful nor damaging and shows disinterest in the performance of others	Discouraging behavior towards other team members	☐		
	Report Writing (PLO10)	Report on all relevant sections related to the lab tasks is completed accurately, meeting the requirements, in prescribed time and with good language skills	Report on all relevant sections related to the lab tasks is completed but few deficiencies are present in terms of accuracy / meeting the requirements / prescribed time / good language skills	Report on all relevant sections related to the lab tasks is completed but many deficiencies are present in terms of accuracy / meeting the requirements / prescribed time / good language skills	Report on all relevant sections related to the lab tasks is not completed	☐		
	Lab Task Management (PLO11)	Manages tasks well within given timeframe	Manages tasks within given timeframe	Manages tasks in an extended timeframe	Does not manage tasks even in extended timeframes	☐		

Lab 6: Shell Scripting Basics

Objective:

Write and execute simple shell scripts to automate tasks.

---

1. Creating and Running Shell Scripts

Step 1: Create a new script file

Step 2: Edit the script file

Step 3: Make the script executable

Step 4: Run the script

```
muhammad@DESKTOP-HA2PTL5:~$ mkdir lab6
muhammad@DESKTOP-HA2PTL5:~$ cd lab6
muhammad@DESKTOP-HA2PTL5:~/lab6$ touch myscript.sh
muhammad@DESKTOP-HA2PTL5:~/lab6$ nano myscript.sh
muhammad@DESKTOP-HA2PTL5:~/lab6$ chmod +x myscript.sh
muhammad@DESKTOP-HA2PTL5:~/lab6$ ./myscript.sh
./myscript.sh: line 1: Muhammad: command not found
./myscript.sh: line 2: 23-ST-017: command not found
./myscript.sh: line 3: Software: command not found
./myscript.sh: line 4: Linux: command not found
./myscript.sh: line 5: PTUT: command not found
./myscript.sh: line 6: XYZ: command not found
```

2. Using Variables and Simple Control Structures

- **Define and use variables in a script**

```
muhammad@DESKTOP-HA2PTL5:~/lab6$ #!/bin/bash
name="Muhammad"
echo "Hello, $name!"
Hello, Muhammad!
```

- **Use conditional statements**

```
muhammad@DESKTOP-HA2PTL5:~/lab6$ #!/bin/bash
if [ "$1" == "hello" ]; then
  echo "Hello, World!"
else
  echo "Goodbye!"
fi
Goodbye!
```

- **Use loops in a script**

```
muhammad@DESKTOP-HA2PTL5:~/lab6$ #!/bin/bash
for i in {1..5}; do
  echo "Iteration $i"
done
Iteration 1
Iteration 2
Iteration 3
Iteration 4
Iteration 5
```

3. Input/Output Redirection

- **Redirect output to a file and Redirect input from a file and append output to file.**

```
muhammad@DESKTOP-HA2PTL5:~$ cd lab6
muhammad@DESKTOP-HA2PTL5:~/lab6$ echo "This is a test" > output.txt
muhammad@DESKTOP-HA2PTL5:~/lab6$ echo "New line" >> output.txt
muhammad@DESKTOP-HA2PTL5:~/lab6$ wc -l < output.txt
2
muhammad@DESKTOP-HA2PTL5:~/lab6$ cat output.txt
This is a test
New line
```

4. Automating Daily Tasks with Scripts

- **Write a backup script**

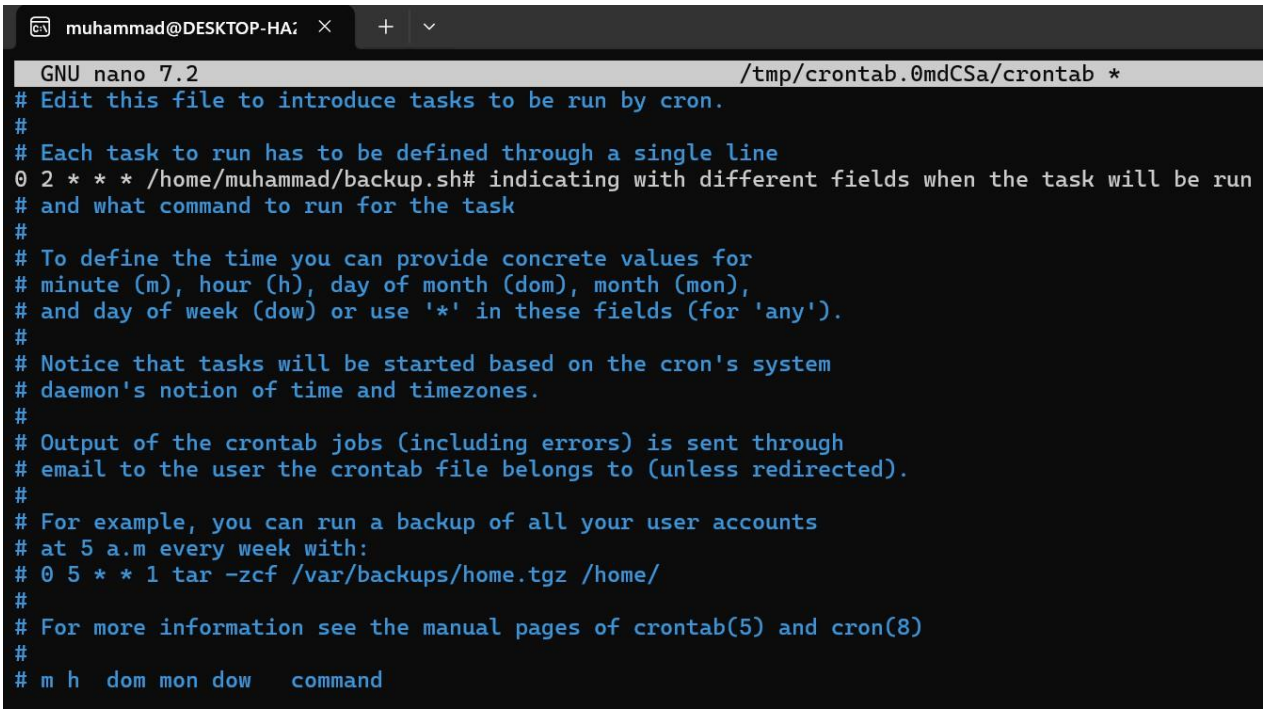
```
muhammad@DESKTOP-HA2PTL5:~/lab6$ #!/bin/bash
tar -czf backup.tar.gz /home/muhammad/lab6
tar: Removing leading `/' from member names
```

- **Schedule the script with cron**

```
muhammad@DESKTOP-HA2PTL5:~/lab6$ crontab -e
no crontab for muhammad - using an empty one

Select an editor.  To change later, run 'select-editor'.
  1. /bin/nano        <---- easiest
  2. /usr/bin/vim.basic
  3. /usr/bin/vim.tiny
  4. /bin/ed

Choose 1-4 [1]: 1
crontab: installing new crontab
```



- **Verify Scheduled Jobs**

```
muhammad@DESKTOP-HA2PTL5:~/lab6$ crontab -l
# Edit this file to introduce tasks to be run by cron.
#
# Each task to run has to be defined through a single line
0 2 * * * /home/muhammad/backup.sh# indicating with different fields when the task will be run
# and what command to run for the task
#
# To define the time you can provide concrete values for
# minute (m), hour (h), day of month (dom), month (mon),
# and day of week (dow) or use '*' in these fields (for 'any').
#
# Notice that tasks will be started based on the cron's system
# daemon's notion of time and timezones.
#
# Output of the crontab jobs (including errors) is sent through
# email to the user the crontab file belongs to (unless redirected).
#
# For example, you can run a backup of all your user accounts
# at 5 a.m every week with:
# 0 5 * * 1 tar -zcf /var/backups/home.tgz /home/
#
# For more information see the manual pages of crontab(5) and cron(8)
#
# m h  dom mon dow   command
```

---

5. Monitoring System Performance

- **Check CPU and Memory Usage**

```
muhammad@DESKTOP-HA2PTL5:~/lab6$ vmstat 1 5
procs -----------memory---------- ---swap-- -----io---- -system-- -------cpu-------
 r  b   swpd   free   buff  cache   si   so    bi    bo   in   cs us sy id wa st gu
 1  0      0 3389688   3108 143548    0    0   191    22   34    0  0  0 100  0  0  0
 0  0      0 3389688   3108 143600    0    0     0     0    3   39  0  0 100  0  0  0
 0  0      0 3389688   3108 143600    0    0     0     0    4   30  0  0 100  0  0  0
 0  0      0 3389688   3108 143600    0    0     0     0    4   34  0  0 100  0  0  0
 0  0      0 3389688   3108 143600    0    0     0     0    4   30  0  0 100  0  0  0
```

- **Monitor Disk I/O Usage**

```
muhammad@DESKTOP-HA2PTL5:~/lab6$ iostat
Linux 5.15.167.4-microsoft-standard-WSL2 (DESKTOP-HA2PTL5)      03/22/25        _x86_64_        (8 CPU)

avg-cpu:  %user   %nice %system %iowait  %steal   %idle
          0.06    0.00    0.12    0.07    0.00   99.75

Device             tps    kB_read/s    kB_wrtn/s    kB_dscd/s    kB_read    kB_wrtn    kB_dscd
sda               0.74        49.01         0.00         0.00      73953          0          0
sdb               0.07         1.48         0.00         0.00       2228          4          0
sdc               8.63       138.22        22.28        22.06     208585      33616      33284
```

- **Check Available Memory**

```
muhammad@DESKTOP-HA2PTL5:~/lab6$ free -h
               total        used        free      shared  buff/cache   available
Mem:           3.7Gi       556Mi       3.2Gi       3.1Mi       143Mi       3.2Gi
Swap:          1.0Gi          0B       1.0Gi
muhammad@DESKTOP-HA2PTL5:~/lab6$
```

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Cognitive	**Recording Measurements** (Hardware / Software)	Is able to record accurate measurements all the time	Is able to record accurate measurements most of the time	Is only able to record accurate measurements on some occasions	Is unable to record accurate measurements	☐		
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	Attitude (PLO9)	Internalized positive behavior and encourages and helps other team members	Consistent positive behavior most of the time towards other team members	Neither helpful nor damaging and shows disinterest in the performance of others	Discouraging behavior towards other team members	☐		
	Report Writing (PLO10)	Report on all relevant sections related to the lab tasks is completed accurately, meeting the requirements, in prescribed time and with good language skills	Report on all relevant sections related to the lab tasks is completed but few deficiencies are present in terms of accuracy / meeting the requirements / prescribed time / good language skills	Report on all relevant sections related to the lab tasks is completed but many deficiencies are present in terms of accuracy / meeting the requirements / prescribed time / good language skills	Report on all relevant sections related to the lab tasks is not completed	☐		
	Lab Task Management (PLO11)	Manages tasks well within given timeframe	Manages tasks within given timeframe	Manages tasks in an extended timeframe	Does not manage tasks even in extended timeframes	☐		

Lab 7: Advanced Shell Scripting

Objective:

Explore advanced shell scripting techniques including loops, conditionals, functions, and task scheduling.

1. Loops and Conditional Statements

- **Using for and while loops**

```
muhammad@DESKTOP-HA2PTL5:~$ mkdir lab7
muhammad@DESKTOP-HA2PTL5:~$ cd lab7
muhammad@DESKTOP-HA2PTL5:~/lab7$ #!/bin/bash
for i in {1..5}; do
  echo "Iteration $i"
done
Iteration 1
Iteration 2
Iteration 3
Iteration 4
Iteration 5
muhammad@DESKTOP-HA2PTL5:~/lab7$ #!/bin/bash
count=1
while [ $count -le 5 ]; do
  echo "Count: $count"
  ((count++))
done
Count: 1
Count: 2
Count: 3
Count: 4
Count: 5
```

- **Using if statements**

```
muhammad@DESKTOP-HA2PTL5:~/lab7$ #!/bin/bash
num=10
if [ $num -gt 5 ]; then
  echo "Number is greater than 5"
else
  echo "Number is 5 or less"
fi
Number is greater than 5
```

- **Using case statements**

```
muhammad@DESKTOP-HA2PTL5:~/lab7$ #!/bin/bash
echo "Enter a choice:"
read choice
case $choice in
  1) echo "You selected option 1" ;;
  2) echo "You selected option 2" ;;
  *) echo "Invalid option" ;;
esac
Enter a choice:
1
You selected option 1
```

2. Functions in Shell Scripts

- **Defining and calling functions**

```
muhammad@DESKTOP-HA2PTL5:~/lab7$ #!/bin/bash
greet() {
  echo "Hello, $1!"
}
greet "Muhammad"
Hello, Muhammad!
```

3. Automating Tasks with Crontab

- **Write a system monitoring script**

```
muhammad@DESKTOP-HA2PTL5:~/lab7$ #!/bin/bash
echo "System Monitoring Report" > system_report.txt
echo "------------------------" >> system_report.txt
date >> system_report.txt
echo "CPU Usage:" >> system_report.txt
top -b -n 1 | head -10 >> system_report.txt
free -h >> system_report.txt
echo "Disk Usage:" >> system_report.txt
df -h >> system_report.txt
echo "Report generated at $(date)" >> system_report.txt
```

```
muhammad@DESKTOP-HA2PTL5:~/lab7$ cat system_report.txt
System Monitoring Report
------------------------
Sat Mar 22 11:26:05 PKT 2025
CPU Usage:
top - 11:26:05 up 11 min,  1 user,  load average: 0.03, 0.01, 0.00
Tasks:  24 total,   1 running,  23 sleeping,   0 stopped,   0 zombie
%Cpu(s):  0.0 us,  0.0 sy,  0.0 ni, 98.9 id,  1.1 wa,  0.0 hi,  0.0 si,  0.0 st
MiB Mem :   3822.0 total,   3352.5 free,    527.4 used,    112.9 buff/cache
MiB Swap:   1024.0 total,   1024.0 free,      0.0 used.   3294.6 avail Mem

    PID USER      PR  NI    VIRT    RES    SHR S  %CPU  %MEM     TIME+ COMMAND
      1 root      20   0   21500  12900   9604 S   0.0   0.3   0:01.04 systemd
      2 root      20   0    2776   1924   1796 S   0.0   0.0   0:00.02 init-sy+
      6 root      20   0    2776    132    132 S   0.0   0.0   0:00.01 init
               total        used        free      shared  buff/cache   available
Mem:           3.7Gi       527Mi       3.3Gi       3.1Mi       113Mi       3.2Gi
Swap:          1.0Gi          0B       1.0Gi
Disk Usage:
Filesystem      Size  Used Avail Use% Mounted on
none            1.9G     0  1.9G   0% /usr/lib/modules/5.15.167.4-microsoft-standard-WSL2
none            1.9G  4.0K  1.9G   1% /mnt/wsl
drivers         238G   85G  154G  36% /usr/lib/wsl/drivers
/dev/sdc       1007G  1.6G  955G   1% /
none            1.9G   76K  1.9G   1% /mnt/wslg
none            1.9G     0  1.9G   0% /usr/lib/wsl/lib
rootfs          1.9G  2.4M  1.9G   1% /init
none            1.9G  492K  1.9G   1% /run
none            1.9G     0  1.9G   0% /run/lock
none            1.9G     0  1.9G   0% /run/shm
tmpfs           4.0M     0  4.0M   0% /sys/fs/cgroup
none            1.9G   76K  1.9G   1% /mnt/wslg/versions.txt
```

- **Schedule the script using crontab**

```
muhammad@DESKTOP-HA2PTL5:~/lab7$ crontab -e
crontab: installing new crontab
```

```
# Edit this file to introduce tasks to be run by cron.
#
# Each task to run has to be defined through a single line
0 2 * * * /home/muhammad/backup.sh# indicating with different fields when the task will be run
# and what command to run for the task
0 3 * * * /home/muhammad/monitor.sh#
# To define the time you can provide concrete values for
# minute (m), hour (h), day of month (dom), month (mon),
# and day of week (dow) or use '*' in these fields (for 'any').
#
# Notice that tasks will be started based on the cron's system
# daemon's notion of time and timezones.
#
# Output of the crontab jobs (including errors) is sent through
# email to the user the crontab file belongs to (unless redirected).
#
# For example, you can run a backup of all your user accounts
# at 5 a.m every week with:
# 0 5 * * 1 tar -zcf /var/backups/home.tgz /home/
#
# For more information see the manual pages of crontab(5) and cron(8)
#
# m h  dom mon dow   command
```

- **Verify Scheduled Jobs**

```
muhammad@DESKTOP-HA2PTL5:~/lab7$ crontab -l
# Edit this file to introduce tasks to be run by cron.
#
# Each task to run has to be defined through a single line
0 2 * * * /home/muhammad/backup.sh# indicating with different fields when the task will be run
# and what command to run for the task
0 3 * * * /home/muhammad/monitor.sh#
# To define the time you can provide concrete values for
# minute (m), hour (h), day of month (dom), month (mon),
# and day of week (dow) or use '*' in these fields (for 'any').
#
# Notice that tasks will be started based on the cron's system
# daemon's notion of time and timezones.
#
# Output of the crontab jobs (including errors) is sent through
# email to the user the crontab file belongs to (unless redirected).
#
# For example, you can run a backup of all your user accounts
# at 5 a.m every week with:
# 0 5 * * 1 tar -zcf /var/backups/home.tgz /home/
#
# For more information see the manual pages of crontab(5) and cron(8)
#
# m h  dom mon dow   command
```

4. Monitoring System Performance

➢ Check CPU and Memory Usage

```
muhammad@DESKTOP-HA2PTL5:~$ cd lab7
muhammad@DESKTOP-HA2PTL5:~/lab7$ vmstat 1 5
procs -----------memory---------- ---swap-- -----io---- -system-- -------cpu-------
 r  b   swpd   free   buff  cache   si   so    bi    bo   in   cs us sy id wa st gu
 1  0      0 3400652   2648 119440    0    0   166    15   37    0  0  0 100  0  0  0
 0  0      0 3400652   2648 119440    0    0     0     0    4   35  0  0 100  0  0  0
 0  0      0 3400652   2656 119432    0    0     0    24    9   51  0  0 99  1  0  0
 0  0      0 3400652   2656 119432    0    0     0     0    3   28  0  0 100  0  0  0
 0  0      0 3400652   2656 119480    0    0     0     0   16   66  0  0 100  0  0  0
```

➢ Monitor Disk I/O Usage

```
muhammad@DESKTOP-HA2PTL5:~/lab7$ iostat
Linux 5.15.167.4-microsoft-standard-WSL2 (DESKTOP-HA2PTL5)      03/22/25        _x86_64_        (8 CPU)

avg-cpu:  %user   %nice %system %iowait  %steal   %idle
          0.06    0.00    0.12    0.07    0.00   99.75

Device             tps    kB_read/s    kB_wrtn/s    kB_dscd/s    kB_read    kB_wrtn    kB_dscd
sda               0.78        52.08         0.00         0.00      73953          0          0
sdb               0.07         1.57         0.00         0.00       2228          4          0
sdc               3.68       111.98        15.33        18.23     159001      21768      25884
```

➢ Check Available Memory

```
muhammad@DESKTOP-HA2PTL5:~/lab7$ free -h
               total        used        free      shared  buff/cache   available
Mem:           3.7Gi       555Mi       3.2Gi       3.1Mi       119Mi       3.2Gi
Swap:          1.0Gi          0B       1.0Gi
```

GENERALIZED LAB RUBRICS

Domain	Component with Taxonomy	Above Expectation (4)	Meeting Expectation (3)	Approaching Expectation (2)	Below Expectation (1)	Used	Weight / 100 (Optional)	Score (1–4)
Psychomotor	**Building (**Hardware)	Is able to build a given setup neatly and timely using correct hardware components and / or can reorganize / adapt to new / special requirements	Is able to assemble a given setup using correct hardware components after minor revisions	Is only able to copy a given setup using correct hardware components	Is not able to assemble a given setup using correct hardware components	☐		
Cognitive	**Recording Measurements** (Hardware / Software)	Is able to record accurate measurements all the time	Is able to record accurate measurements most of the time	Is only able to record accurate measurements on some occasions	Is unable to record accurate measurements	☐		
	Investigation (Software)	Is able to formulate /develop theories in addition to evaluating /concluding correctly about investigation parameters by assessing data	Is able to evaluate /conclude correctly about investigation parameters by assessing data	Is partially able to evaluate /conclude correctly about investigation parameters by assessing data	Is unable to comprehend investigation parameters	☐		
	Design / Development of Solution (Hardware / Software)	Is able to design / develop the solution of a given problem and add features to it	Is able to design / develop the solution of a given problem	Is able to partially design / develop the solution of a given problem	Is unable to partially design / develop the solution of a given problem	☐		
	Software Usage (Software)	Is adept in the use of software tool and can access advanced features	Is able to use the software tool effectively by accessing all the required features	Is able to use the software tool but cannot access all the required features	Is unable to use the software tool	☐		
	Programming Language (Software)	Is able to efficiently complete a given task using advanced programming language constructs / methods / commands and/or add features to the original task	Is able to complete a given task using required programming language constructs / methods / commands	Is able to partially complete a given task	Is unable to partially complete a given task	☐		

GENERALIZED LAB RUBRICS

Domain	Component with Taxonomy	Above Expectation (4)	Meeting Expectation (3)	Approaching Expectation (2)	Below Expectation (1)	Used	Weight / 100 (Optional)	Score (1–4)
Affective	**Safety Instructions (PLO6)**	Assesses and complies with all EHS instructions while in lab	Assesses and complies with most EHS instructions while in lab	Assesses and complies with some EHS instructions while in lab	Assesses and complies with few EHS instructions in lab	☐		
	Professional Ethics (PLO8)	Exhibits exemplary professional ethics while writing lab reports and dealing with fellow students, lab staff and instructor all the time	Exhibits professional ethics while writing lab reports and dealing with fellow students, lab staff and instructor all the time	Makes an effort to exhibit professional ethics while writing lab reports and dealing with fellow students, lab staff and instructor all the time	Does not exhibit professional ethics while writing lab reports and dealing with fellow students, lab staff and instructor all the time	☐		
	Contribution (PLO9)	Consistently shows full preparation by completing all agreed tasks and provides additional resources for the group and work quality is excellent	Consistently shows full preparation by completing all agreed tasks and work requires little or no revisions	Shows some preparation which is mostly at superficial level in completing a task and work requires much revisions and editing	Shows very little or no preparation in completing a task and work quality is poor	☐		
	Attitude (PLO9)	Internalized positive behavior and encourages and helps other team members	Consistent positive behavior most of the time towards other team members	Neither helpful nor damaging and shows disinterest in the performance of others	Discouraging behavior towards other team members	☐		
	Report Writing (PLO10)	Report on all relevant sections related to the lab tasks is completed accurately, meeting the requirements, in prescribed time and with good language skills	Report on all relevant sections related to the lab tasks is completed but few deficiencies are present in terms of accuracy / meeting the requirements / prescribed time / good language skills	Report on all relevant sections related to the lab tasks is completed but many deficiencies are present in terms of accuracy / meeting the requirements / prescribed time / good language skills	Report on all relevant sections related to the lab tasks is not completed	☐		
	Lab Task Management (PLO11)	Manages tasks well within given timeframe	Manages tasks within given timeframe	Manages tasks in an extended timeframe	Does not manage tasks even in extended timeframes	☐		

Lab 8: Package Management

Objective:

Learn how to install, update, and manage software packages using different package managers.

1. Understanding Package Managers

Package managers help in installing, updating, and removing software efficiently. Different Linux distributions use different package managers:

- **APT (apt)** – Used in Debian-based systems like Ubuntu.
- **YUM (yum)** and **DNF (dnf)** – Used in Red Hat-based systems like CentOS and Fedora.

---

2. Installing Software Packages

- **Ubuntu/Debian (apt):**

```
muhammad@DESKTOP-HA2PTL5:~$ sudo apt update
sudo apt install curl vim
[sudo] password for muhammad:
Get:1 http://security.ubuntu.com/ubuntu noble-security InRelease [126 kB]
Hit:2 http://archive.ubuntu.com/ubuntu noble InRelease
Get:3 http://archive.ubuntu.com/ubuntu noble-updates InRelease [126 kB]
Get:4 http://security.ubuntu.com/ubuntu noble-security/main amd64 Packages [671 kB]
Get:5 http://archive.ubuntu.com/ubuntu noble-backports InRelease [126 kB]
Get:6 http://archive.ubuntu.com/ubuntu noble-updates/main amd64 Packages [922 kB]
Get:7 http://security.ubuntu.com/ubuntu noble-security/main amd64 Components [9024 B]
Get:8 http://security.ubuntu.com/ubuntu noble-security/main amd64 c-n-f Metadata [6936 B]
Get:9 http://security.ubuntu.com/ubuntu noble-security/universe amd64 Packages [820 kB]
Get:10 http://security.ubuntu.com/ubuntu noble-security/universe Translation-en [177 kB]
Get:11 http://security.ubuntu.com/ubuntu noble-security/universe amd64 Components [51.9 kB]
Get:12 http://security.ubuntu.com/ubuntu noble-security/universe amd64 c-n-f Metadata [17.0 kB]
Get:13 http://security.ubuntu.com/ubuntu noble-security/restricted amd64 Components [208 B]
Get:14 http://security.ubuntu.com/ubuntu noble-security/multiverse amd64 Components [208 B]
Get:15 http://archive.ubuntu.com/ubuntu noble-updates/main amd64 Components [151 kB]
Get:16 http://archive.ubuntu.com/ubuntu noble-updates/main amd64 c-n-f Metadata [13.5 kB]
Get:17 http://archive.ubuntu.com/ubuntu noble-updates/universe amd64 Packages [1041 kB]
Get:18 http://archive.ubuntu.com/ubuntu noble-updates/universe Translation-en [262 kB]
Get:19 http://archive.ubuntu.com/ubuntu noble-updates/universe amd64 Components [364 kB]
Get:20 http://archive.ubuntu.com/ubuntu noble-updates/universe amd64 c-n-f Metadata [25.9 kB]
Get:21 http://archive.ubuntu.com/ubuntu noble-updates/restricted amd64 Components [212 B]
Get:22 http://archive.ubuntu.com/ubuntu noble-updates/multiverse amd64 Components [940 B]
Get:23 http://archive.ubuntu.com/ubuntu noble-backports/main amd64 Packages [39.1 kB]
Get:24 http://archive.ubuntu.com/ubuntu noble-backports/main Translation-en [8676 B]
Get:25 http://archive.ubuntu.com/ubuntu noble-backports/main amd64 Components [7076 B]
Get:26 http://archive.ubuntu.com/ubuntu noble-backports/main amd64 c-n-f Metadata [272 B]
Get:27 http://archive.ubuntu.com/ubuntu noble-backports/universe amd64 Packages [26.4 kB]
```

3. Updating and Removing Packages

- **Update all installed packages:**
- **For Ubuntu/Debian:**

```
muhammad@DESKTOP-HA2PTL5:~$ sudo apt update && sudo apt upgrade -y
[sudo] password for muhammad:
Hit:1 http://archive.ubuntu.com/ubuntu noble InRelease
Hit:2 http://security.ubuntu.com/ubuntu noble-security InRelease
Hit:3 http://archive.ubuntu.com/ubuntu noble-updates InRelease
Hit:4 http://archive.ubuntu.com/ubuntu noble-backports InRelease
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
125 packages can be upgraded. Run 'apt list --upgradable' to see them.
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
Calculating upgrade... Done
The following package was automatically installed and is no longer required:
  libllvm17t64
Use 'sudo apt autoremove' to remove it.
The following NEW packages will be installed:
  ethtool libllvm19 mesa-libgallium
The following upgrades have been deferred due to phasing:
  cloud-init
```

- **Remove an installed package:**
- **For Ubuntu/Debian:**

```
muhammad@DESKTOP-HA2PTL5:~$ sudo apt remove vim
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
The following packages were automatically installed and are no longer required:
  libpython3.12t64 libsodium23 vim-runtime
Use 'sudo apt autoremove' to remove them.
The following packages will be REMOVED:
  ubuntu-wsl vim
0 upgraded, 0 newly installed, 2 to remove and 124 not upgraded.
After this operation, 4247 kB disk space will be freed.
Do you want to continue? [Y/n] y
(Reading database ... 40880 files and directories currently installed.)
Removing ubuntu-wsl (1.539.1) ...
Removing vim (2:9.1.0016-1ubuntu7.6) ...
update-alternatives: using /usr/bin/vim.tiny to provide /usr/bin/view (view) in auto mode
update-alternatives: using /usr/bin/vim.tiny to provide /usr/bin/vi (vi) in auto mode
update-alternatives: using /usr/bin/vim.tiny to provide /usr/bin/rview (rview) in auto mode
update-alternatives: using /usr/bin/vim.tiny to provide /usr/bin/ex (ex) in auto mode
```

4. Cleaning Up Unused Packages

To free up space and remove unnecessary dependencies:

- **For Ubuntu/Debian:**

```
muhammad@DESKTOP-HA2PTL5:~$  sudo apt autoremove
sudo apt clean
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
The following packages will be REMOVED:
  libpython3.12t64 libsodium23 vim-runtime
0 upgraded, 0 newly installed, 3 to remove and 123 not upgraded.
After this operation, 46.9 MB disk space will be freed.
Do you want to continue? [Y/n] y
(Reading database ... 40869 files and directories currently installed.)
Removing libpython3.12t64:amd64 (3.12.3-1ubuntu0.3) ...
Removing libsodium23:amd64 (1.0.18-1build3) ...
Removing vim-runtime (2:9.1.0016-1ubuntu7.6) ...
Removing 'diversion of /usr/share/vim/vim91/doc/help.txt to /usr/share/vim/vim91/doc/help.txt.vim-tiny by vim-runtime'
Removing 'diversion of /usr/share/vim/vim91/doc/tags to /usr/share/vim/vim91/doc/tags.vim-tiny by vim-runtime'
Processing triggers for man-db (2.12.0-4build2) ...
Processing triggers for libc-bin (2.39-0ubuntu8.3) ...
```

5. Managing Repositories

Repositories store software packages and updates. You can list available repositories:

- **For Ubuntu/Debian:**

```
muhammad@DESKTOP-HA2PTL5:~$ cat /etc/apt/sources.list
# Ubuntu sources have moved to the /etc/apt/sources.list.d/ubuntu.sources
# file, which uses the deb822 format. Use deb822-formatted .sources files
# to manage package sources in the /etc/apt/sources.list.d/ directory.
# See the sources.list(5) manual page for details.
muhammad@DESKTOP-HA2PTL5:~$
```

6. Verify Installed Packages

- **For Ubuntu/Debian:**

```
muhammad@DESKTOP-HA2PTL5:~$ dpkg -l | grep curl
ii  curl                          8.5.0-2ubuntu10.6                amd64        command line tool for transferring data with U
RL syntax
ii  libcurl3t64-gnutls:amd64      8.5.0-2ubuntu10.6                amd64        easy-to-use client-side URL transfer library (
GnuTLS flavour)
ii  libcurl4t64:amd64             8.5.0-2ubuntu10.6                amd64        easy-to-use client-side URL transfer library (
OpenSSL flavour)
ii  python3-pycurl                7.45.3-1build2                   amd64        Python bindings to libcurl (Python 3)
muhammad@DESKTOP-HA2PTL5:~$
```

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Psychomotor	**Building (**Hardware)	Is able to build a given setup neatly and timely using correct hardware components and / or can reorganize / adapt to new / special requirements	Is able to assemble a given setup using correct hardware components after minor revisions	Is only able to copy a given setup using correct hardware components	Is not able to assemble a given setup using correct hardware components	☐		
Cognitive	**Recording Measurements** (Hardware / Software)	Is able to record accurate measurements all the time	Is able to record accurate measurements most of the time	Is only able to record accurate measurements on some occasions	Is unable to record accurate measurements	☐		
	Investigation (Software)	Is able to formulate /develop theories in addition to evaluating /concluding correctly about investigation parameters by assessing data	Is able to evaluate /conclude correctly about investigation parameters by assessing data	Is partially able to evaluate /conclude correctly about investigation parameters by assessing data	Is unable to comprehend investigation parameters	☐		
	Design / Development of Solution (Hardware / Software)	Is able to design / develop the solution of a given problem and add features to it	Is able to design / develop the solution of a given problem	Is able to partially design / develop the solution of a given problem	Is unable to partially design / develop the solution of a given problem	☐		
	Software Usage (Software)	Is adept in the use of software tool and can access advanced features	Is able to use the software tool effectively by accessing all the required features	Is able to use the software tool but cannot access all the required features	Is unable to use the software tool	☐		
	Programming Language (Software)	Is able to efficiently complete a given task using advanced programming language constructs / methods / commands and/or add features to the original task	Is able to complete a given task using required programming language constructs / methods / commands	Is able to partially complete a given task	Is unable to partially complete a given task	☐		

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Affective	**Safety Instructions (PLO6)**	Assesses and complies with all EHS instructions while in lab	Assesses and complies with most EHS instructions while in lab	Assesses and complies with some EHS instructions while in lab	Assesses and complies with few EHS instructions in lab	☐		
	Professional Ethics (PLO8)	Exhibits exemplary professional ethics while writing lab reports and dealing with fellow students, lab staff and instructor all the time	Exhibits professional ethics while writing lab reports and dealing with fellow students, lab staff and instructor all the time	Makes an effort to exhibit professional ethics while writing lab reports and dealing with fellow students, lab staff and instructor all the time	Does not exhibit professional ethics while writing lab reports and dealing with fellow students, lab staff and instructor all the time	☐		
	Contribution (PLO9)	Consistently shows full preparation by completing all agreed tasks and provides additional resources for the group and work quality is excellent	Consistently shows full preparation by completing all agreed tasks and work requires little or no revisions	Shows some preparation which is mostly at superficial level in completing a task and work requires much revisions and editing	Shows very little or no preparation in completing a task and work quality is poor	☐		
	Attitude (PLO9)	Internalized positive behavior and encourages and helps other team members	Consistent positive behavior most of the time towards other team members	Neither helpful nor damaging and shows disinterest in the performance of others	Discouraging behavior towards other team members	☐		
	Report Writing (PLO10)	Report on all relevant sections related to the lab tasks is completed accurately, meeting the requirements, in prescribed time and with good language skills	Report on all relevant sections related to the lab tasks is completed but few deficiencies are present in terms of accuracy / meeting the requirements / prescribed time / good language skills	Report on all relevant sections related to the lab tasks is completed but many deficiencies are present in terms of accuracy / meeting the requirements / prescribed time / good language skills	Report on all relevant sections related to the lab tasks is not completed	☐		
	Lab Task Management (PLO11)	Manages tasks well within given timeframe	Manages tasks within given timeframe	Manages tasks in an extended timeframe	Does not manage tasks even in extended timeframes	☐		

Lab 9: Disk and Partition Management

Objective:

Learn disk and partition management basics, including disk space usage, mounting/unmounting file systems, and partitioning.

1. Checking Disk Space Usage

➢ **Check Overall Disk Space (df command)**

```
muhammad@DESKTOP-HA2PTL5:~$ df -h
Filesystem      Size  Used Avail Use% Mounted on
none            1.9G     0  1.9G   0% /usr/lib/modules/5.15.167.4-microsoft-standard-WSL2
none            1.9G  4.0K  1.9G   1% /mnt/wsl
drivers         238G   84G  154G  36% /usr/lib/wsl/drivers
/dev/sdc       1007G  1.7G  954G   1% /
none            1.9G   76K  1.9G   1% /mnt/wslg
none            1.9G     0  1.9G   0% /usr/lib/wsl/lib
rootfs          1.9G  2.4M  1.9G   1% /init
none            1.9G  492K  1.9G   1% /run
none            1.9G     0  1.9G   0% /run/lock
none            1.9G     0  1.9G   0% /run/shm
tmpfs           4.0M     0  4.0M   0% /sys/fs/cgroup
none            1.9G   76K  1.9G   1% /mnt/wslg/versions.txt
none            1.9G   76K  1.9G   1% /mnt/wslg/doc
C:\             238G   84G  154G  36% /mnt/c
tmpfs           383M   16K  383M   1% /run/user/1000
```

- -h flag shows human-readable format (GB, MB).
- This command lists mounted file systems and available space.

➢ **Check Disk Usage in a Specific Folder (du command).**

```
muhammad@DESKTOP-HA2PTL5:~$  du -sh /home
84K     /home
```

2. Mounting and Unmounting a USB Drive:

➢ **Mount the USB Drive in WSL and verify**

➢

```
muhammad@DESKTOP-HA2PTL5:~$  sudo mkdir /mnt/d
```

```
muhammad@DESKTOP-HA2PTL5:~$ sudo mount -t drvfs D: /mnt/d
muhammad@DESKTOP-HA2PTL5:~$ ls /mnt/d
'Adobe Photoshop 2020 x64'              Office2024                  'Univerisity Semmester 4th'
'Maschine Learning'                     'Software Development'      'univerisity semmester 2nd'
'Office 2016 Pro Plus VLx64 OCT 2021'   'System Volume Information'
```

➢ **Unmount the USB Drive Safely**

```
muhammad@DESKTOP-HA2PTL5:~$ sudo umount /mnt/d
muhammad@DESKTOP-HA2PTL5:~$ ls /mnt/d
muhammad@DESKTOP-HA2PTL5:~$
```

3. Partitioning a Drive and Mount and Unmount USB

➢ **Create a new partition**

- Type n (new partition)

- Choose p (primary partition)
- Press **Enter** to accept default values for size
- Type w to write changes and exit

```
muhammad@DESKTOP-HA2PTL5:~$ sudo fdisk /dev/sdb

Welcome to fdisk (util-linux 2.39.3).
Changes will remain in memory only, until you decide to write them.
Be careful before using the write command.

The device contains 'swap' signature and it will be removed by a write command. See fdisk(8)
ils.

Device does not contain a recognized partition table.
Created a new DOS (MBR) disklabel with disk identifier 0x06dcf59b.

Command (m for help): n
Partition type
   p   primary (0 primary, 0 extended, 4 free)
   e   extended (container for logical partitions)
Select (default p): p
Partition number (1-4, default 1):
First sector (2048-2097159, default 2048):
Last sector, +/-sectors or +/-size{K,M,G,T,P} (2048-2097159, default 2097159): +500M

Created a new partition 1 of type 'Linux' and of size 500 MiB.

Command (m for help): w
The partition table has been altered.
Calling ioctl() to re-read partition table.
Syncing disks.
```

- **Format the partition**

```
muhammad@DESKTOP-HA2PTL5:~$ sudo mkfs.ext4 /dev/sdb1
mke2fs 1.47.0 (5-Feb-2023)
Discarding device blocks: done
Creating filesystem with 128000 4k blocks and 128000 inodes
Filesystem UUID: 9e7dbddc-9d1c-4f12-a238-96063c276081
Superblock backups stored on blocks:
        32768, 98304

Allocating group tables: done
Writing inode tables: done
Creating journal (4096 blocks): done
Writing superblocks and filesystem accounting information: done
```

Mount the Partition:

```
muhammad@DESKTOP-HA2PTL5:~$ sudo mkdir /mnt/usbdrive
muhammad@DESKTOP-HA2PTL5:~$ sudo mount /dev/sdb1 /mnt/usbdrive
muhammad@DESKTOP-HA2PTL5:~$ lsblk
df -h | grep /mnt/usbdrive
NAME   MAJ:MIN RM   SIZE RO TYPE MOUNTPOINTS
sda      8:0    0 388.4M  1 disk
sdb      8:16   0     1G  0 disk
└─sdb1   8:17   0   500M  0 part /mnt/usbdrive
sdc      8:32   0     1T  0 disk /mnt/wslg/distro
                                 /
/dev/sdb1       452M   24K  417M   1% /mnt/usbdrive
```

Unmount the USB Drive:

```
muhammad@DESKTOP-HA2PTL5:~$ sudo umount /mnt/usbdrive
muhammad@DESKTOP-HA2PTL5:~$ lsblk
NAME   MAJ:MIN RM   SIZE RO TYPE MOUNTPOINTS
sda      8:0    0 388.4M  1 disk
sdb      8:16   0     1G  0 disk
└─sdb1   8:17   0   500M  0 part
sdc      8:32   0     1T  0 disk /mnt/wslg/distro
                                 /
muhammad@DESKTOP-HA2PTL5:~$
```

GENERALIZED LAB RUBRICS

Domain	Component with Taxonomy	Above Expectation (4)	Meeting Expectation (3)	Approaching Expectation (2)	Below Expectation (1)	Used	Weight / 100 (Optional)	Score (1–4)
Psychomotor	**Building (**Hardware)	Is able to build a given setup neatly and timely using correct hardware components and / or can reorganize / adapt to new / special requirements	Is able to assemble a given setup using correct hardware components after minor revisions	Is only able to copy a given setup using correct hardware components	Is not able to assemble a given setup using correct hardware components	☐		
Cognitive	**Recording Measurements** (Hardware / Software)	Is able to record accurate measurements all the time	Is able to record accurate measurements most of the time	Is only able to record accurate measurements on some occasions	Is unable to record accurate measurements	☐		
	Investigation (Software)	Is able to formulate /develop theories in addition to evaluating /concluding correctly about investigation parameters by assessing data	Is able to evaluate /conclude correctly about investigation parameters by assessing data	Is partially able to evaluate /conclude correctly about investigation parameters by assessing data	Is unable to comprehend investigation parameters	☐		
	Design / Development of Solution (Hardware / Software)	Is able to design / develop the solution of a given problem and add features to it	Is able to design / develop the solution of a given problem	Is able to partially design / develop the solution of a given problem	Is unable to partially design / develop the solution of a given problem	☐		
	Software Usage (Software)	Is adept in the use of software tool and can access advanced features	Is able to use the software tool effectively by accessing all the required features	Is able to use the software tool but cannot access all the required features	Is unable to use the software tool	☐		
	Programming Language (Software)	Is able to efficiently complete a given task using advanced programming language constructs / methods / commands and/or add features to the original task	Is able to complete a given task using required programming language constructs / methods / commands	Is able to partially complete a given task	Is unable to partially complete a given task	☐		

GENERALIZED LAB RUBRICS

Domain	Component with Taxonomy	Above Expectation (4)	Meeting Expectation (3)	Approaching Expectation (2)	Below Expectation (1)	Used	Weight / 100 (Optional)	Score (1–4)
Affective	**Safety Instructions (PLO6)**	Assesses and complies with all EHS instructions while in lab	Assesses and complies with most EHS instructions while in lab	Assesses and complies with some EHS instructions while in lab	Assesses and complies with few EHS instructions in lab	☐		
	Professional Ethics (PLO8)	Exhibits exemplary professional ethics while writing lab reports and dealing with fellow students, lab staff and instructor all the time	Exhibits professional ethics while writing lab reports and dealing with fellow students, lab staff and instructor all the time	Makes an effort to exhibit professional ethics while writing lab reports and dealing with fellow students, lab staff and instructor all the time	Does not exhibit professional ethics while writing lab reports and dealing with fellow students, lab staff and instructor all the time	☐		
	Contribution (PLO9)	Consistently shows full preparation by completing all agreed tasks and provides additional resources for the group and work quality is excellent	Consistently shows full preparation by completing all agreed tasks and work requires little or no revisions	Shows some preparation which is mostly at superficial level in completing a task and work requires much revisions and editing	Shows very little or no preparation in completing a task and work quality is poor	☐		
	Attitude (PLO9)	Internalized positive behavior and encourages and helps other team members	Consistent positive behavior most of the time towards other team members	Neither helpful nor damaging and shows disinterest in the performance of others	Discouraging behavior towards other team members	☐		
	Report Writing (PLO10)	Report on all relevant sections related to the lab tasks is completed accurately, meeting the requirements, in prescribed time and with good language skills	Report on all relevant sections related to the lab tasks is completed but few deficiencies are present in terms of accuracy / meeting the requirements / prescribed time / good language skills	Report on all relevant sections related to the lab tasks is completed but many deficiencies are present in terms of accuracy / meeting the requirements / prescribed time / good language skills	Report on all relevant sections related to the lab tasks is not completed	☐		
	Lab Task Management (PLO11)	Manages tasks well within given timeframe	Manages tasks within given timeframe	Manages tasks in an extended timeframe	Does not manage tasks even in extended timeframes	☐		

Lab 10: Networking Basics

Objective:

Configure and troubleshoot network settings.

Topics:

- Understanding IP addresses and network interfaces.
- Using `ifconfig`, `ip`, `ping`, `netstat`.
- SSH basics and file transfer (`scp`).

1. Check Network Interfaces

- Shows current network interfaces and their IP addresses.

```
muhammad@DESKTOP-HA2PTL5:~$ ifconfig
eth0: flags=4163<UP,BROADCAST,RUNNING,MULTICAST>  mtu 1472
        inet 172.23.52.78  netmask 255.255.240.0  broadcast 172.23.63.255
        inet6 fe80::215:5dff:fe99:b4c6  prefixlen 64  scopeid 0x20<link>
        ether 00:15:5d:99:b4:c6  txqueuelen 1000  (Ethernet)
        RX packets 320  bytes 338007 (338.0 KB)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 236  bytes 18805 (18.8 KB)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0

lo: flags=73<UP,LOOPBACK,RUNNING>  mtu 65536
        inet 127.0.0.1  netmask 255.0.0.0
        inet6 ::1  prefixlen 128  scopeid 0x10<host>
        loop  txqueuelen 1000  (Local Loopback)
        RX packets 24  bytes 2263 (2.2 KB)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 24  bytes 2263 (2.2 KB)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0
```

- Displays detailed IP and interface information.

```
muhammad@DESKTOP-HA2PTL5:~$ ip addr show
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN group default qlen 1000
    link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00
    inet 127.0.0.1/8 scope host lo
       valid_lft forever preferred_lft forever
    inet 10.255.255.254/32 brd 10.255.255.254 scope global lo
       valid_lft forever preferred_lft forever
    inet6 ::1/128 scope host
       valid_lft forever preferred_lft forever
2: eth0: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1472 qdisc mq state UP group default qlen 1000
    link/ether 00:15:5d:99:b4:c6 brd ff:ff:ff:ff:ff:ff
    inet 172.23.52.78/20 brd 172.23.63.255 scope global eth0
       valid_lft forever preferred_lft forever
    inet6 fe80::215:5dff:fe99:b4c6/64 scope link
       valid_lft forever preferred_lft forever
muhammad@DESKTOP-HA2PTL5:~$
```

2. . Check Internet Connection with Ping

```
muhammad@DESKTOP-HA2PTL5:~$ ping google.com -c 4
PING google.com (142.251.42.14) 56(84) bytes of data.
64 bytes from bom12s19-in-f14.1e100.net (142.251.42.14): icmp_seq=1 ttl=109 time=311 ms
64 bytes from bom12s19-in-f14.1e100.net (142.251.42.14): icmp_seq=2 ttl=109 time=290 ms
64 bytes from bom12s19-in-f14.1e100.net (142.251.42.14): icmp_seq=3 ttl=109 time=336 ms
64 bytes from bom12s19-in-f14.1e100.net (142.251.42.14): icmp_seq=4 ttl=109 time=293 ms

--- google.com ping statistics ---
4 packets transmitted, 4 received, 0% packet loss, time 3181ms
rtt min/avg/max/mdev = 290.037/307.353/335.591/18.096 ms
muhammad@DESKTOP-HA2PTL5:~$
```

- Tests network connectivity to the internet.

3. View Network Stats

```
muhammad@DESKTOP-HA2PTL5:~$ netstat -rn
Kernel IP routing table
Destination     Gateway         Genmask         Flags   MSS Window  irtt Iface
0.0.0.0         172.23.48.1     0.0.0.0         UG        0 0          0 eth0
172.23.48.0     0.0.0.0         255.255.240.0   U         0 0          0 eth0
muhammad@DESKTOP-HA2PTL5:~$
```

- Shows the routing table and network stats.

4. Set a Static IP (Simulation in WSL)

➢ Temporarily adds a static IP to interface eth0.

```
muhammad@DESKTOP-HA2PTL5:~$ sudo ip addr add 192.168.1.100/24 dev eth0
[sudo] password for muhammad:
muhammad@DESKTOP-HA2PTL5:~$
```

➢ Verifies the new static IP is applied.

```
muhammad@DESKTOP-HA2PTL5:~$ ip addr show eth0
2: eth0: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1472 qdisc mq state UP group default qlen 1000
    link/ether 00:15:5d:99:b4:c6 brd ff:ff:ff:ff:ff:ff
    inet 172.23.52.78/20 brd 172.23.63.255 scope global eth0
       valid_lft forever preferred_lft forever
    inet 192.168.1.100/24 scope global eth0
       valid_lft forever preferred_lft forever
    inet6 fe80::215:5dff:fe99:b4c6/64 scope link
       valid_lft forever preferred_lft forever
muhammad@DESKTOP-HA2PTL5:~$
```

5. SSH Into Another System (if available)

```
muhammad@DESKTOP-HA2PTL5:~$ ssh muhammad@192.168.1.100
The authenticity of host '192.168.1.100 (192.168.1.100)' can't be established.
ED25519 key fingerprint is SHA256:BoAt4Avk57iMpbLXxTQ9dBZTJggpvWRFxHnzIiejXLI.
This key is not known by any other names.
Are you sure you want to continue connecting (yes/no/[fingerprint])? yes
Warning: Permanently added '192.168.1.100' (ED25519) to the list of known hosts.
muhammad@192.168.1.100's password:
Welcome to Ubuntu 24.04.1 LTS (GNU/Linux 5.15.167.4-microsoft-standard-WSL2 x86_64)

 * Documentation:  https://help.ubuntu.com
 * Management:     https://landscape.canonical.com
 * Support:        https://ubuntu.com/pro

 System information as of Sun Apr  6 08:51:17 PKT 2025

  System load:  0.11               Processes:             32
  Usage of /:   0.2% of 1006.85GB  Users logged in:       1
  Memory usage: 11%                IPv4 address for eth0: 172.23.52.78
  Swap usage:   0%                 IPv4 address for eth0: 192.168.1.100

 * Strictly confined Kubernetes makes edge and IoT secure. Learn how MicroK8s
   just raised the bar for easy, resilient and secure K8s cluster deployment.

   https://ubuntu.com/engage/secure-kubernetes-at-the-edge

The programs included with the Ubuntu system are free software;
the exact distribution terms for each program are described in the
individual files in /usr/share/doc/*/copyright.

Ubuntu comes with ABSOLUTELY NO WARRANTY, to the extent permitted by
applicable law.

Welcome to Ubuntu 24.04.1 LTS (GNU/Linux 5.15.167.4-microsoft-standard-WSL2 x86_64)

 * Documentation:  https://help.ubuntu.com
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 * Strictly confined Kubernetes makes edge and IoT secure. Learn how MicroK8s
   just raised the bar for easy, resilient and secure K8s cluster deployment.

   https://ubuntu.com/engage/secure-kubernetes-at-the-edge
```

- Logs in to a remote machine using SSH.

6. Transfer File Using SCP

```
muhammad@DESKTOP-HA2PTL5:~$ touch testfile.txt
muhammad@DESKTOP-HA2PTL5:~$ nano testfile.txt
muhammad@DESKTOP-HA2PTL5:~$ scp testfile.txt muhammad@192.168.1.100:/home/muhammad/
muhammad@192.168.1.100's password:
testfile.txt
muhammad@DESKTOP-HA2PTL5:~$
```

- Copies a file to another machine over SSH.

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	Software Usage (Software)	Is adept in the use of software tool and can access advanced features	Is able to use the software tool effectively by accessing all the required features	Is able to use the software tool but cannot access all the required features	Is unable to use the software tool	☐		
	Programming Language (Software)	Is able to efficiently complete a given task using advanced programming language constructs / methods / commands and/or add features to the original task	Is able to complete a given task using required programming language constructs / methods / commands	Is able to partially complete a given task	Is unable to partially complete a given task	☐		

GENERALIZED LAB RUBRICS

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	Professional Ethics (PLO8)	Exhibits exemplary professional ethics while writing lab reports and dealing with fellow students, lab staff and instructor all the time	Exhibits professional ethics while writing lab reports and dealing with fellow students, lab staff and instructor all the time	Makes an effort to exhibit professional ethics while writing lab reports and dealing with fellow students, lab staff and instructor all the time	Does not exhibit professional ethics while writing lab reports and dealing with fellow students, lab staff and instructor all the time	☐		
	Contribution (PLO9)	Consistently shows full preparation by completing all agreed tasks and provides additional resources for the group and work quality is excellent	Consistently shows full preparation by completing all agreed tasks and work requires little or no revisions	Shows some preparation which is mostly at superficial level in completing a task and work requires much revisions and editing	Shows very little or no preparation in completing a task and work quality is poor	☐		
	Attitude (PLO9)	Internalized positive behavior and encourages and helps other team members	Consistent positive behavior most of the time towards other team members	Neither helpful nor damaging and shows disinterest in the performance of others	Discouraging behavior towards other team members	☐		
	Report Writing (PLO10)	Report on all relevant sections related to the lab tasks is completed accurately, meeting the requirements, in prescribed time and with good language skills	Report on all relevant sections related to the lab tasks is completed but few deficiencies are present in terms of accuracy / meeting the requirements / prescribed time / good language skills	Report on all relevant sections related to the lab tasks is completed but many deficiencies are present in terms of accuracy / meeting the requirements / prescribed time / good language skills	Report on all relevant sections related to the lab tasks is not completed	☐		
	Lab Task Management (PLO11)	Manages tasks well within given timeframe	Manages tasks within given timeframe	Manages tasks in an extended timeframe	Does not manage tasks even in extended timeframes	☐		

Lab 11: Services and Daemons

Objective: Manage system services.

Topics:

- Starting and stopping services (`systemctl`, `service`).
- Understanding daemons.
- Managing system logs (`journalctl`).

1. Enable and disable services at boot

Objective:

Learn how to configure system services to start automatically at boot, or to disable them.

Steps:

- **Enable a service at boot:**

To enable a service so that it starts automatically at boot time, use the systemctl command. For example, to enable the **SSH service**:

```
muhammad@DESKTOP-HA2PTL5:~$ sudo systemctl enable ssh
[sudo] password for muhammad:
Synchronizing state of ssh.service with SysV service script with /usr/lib/systemd/systemd-sysv-install.
Executing: /usr/lib/systemd/systemd-sysv-install enable ssh
Created symlink /etc/systemd/system/sshd.service → /usr/lib/systemd/system/ssh.service.
Created symlink /etc/systemd/system/multi-user.target.wants/ssh.service → /usr/lib/systemd/system/ssh.service.
muhammad@DESKTOP-HA2PTL5:~$
```

- This ensures the service will start automatically every time the system boots.

- **Disable a service at boot:**

To disable a service from starting at boot, use the following command:

```
muhammad@DESKTOP-HA2PTL5:~$ sudo systemctl disable ssh
Synchronizing state of ssh.service with SysV service script with /usr/lib/systemd/systemd-sysv-install.
Executing: /usr/lib/systemd/systemd-sysv-install disable ssh
Removed "/etc/systemd/system/multi-user.target.wants/ssh.service".
Removed "/etc/systemd/system/sshd.service".
Disabling 'ssh.service', but its triggering units are still active:
ssh.socket
muhammad@DESKTOP-HA2PTL5:~$ sudo systemctl disable ssh
Synchronizing state of ssh.service with SysV service script with /usr/lib/systemd/systemd-sysv-install.
Executing: /usr/lib/systemd/systemd-sysv-install disable ssh
Disabling 'ssh.service', but its triggering units are still active:
ssh.socket
muhammad@DESKTOP-HA2PTL5:~$ sudo systemctl stop ssh.socket
muhammad@DESKTOP-HA2PTL5:~$ sudo systemctl disable ssh.socket
Removed "/etc/systemd/system/ssh.service.requires/ssh.socket".
Removed "/etc/systemd/system/sockets.target.wants/ssh.socket".
muhammad@DESKTOP-HA2PTL5:~$
```

- This stops the SSH service from starting automatically at boot.

2. Start and stop services manually

To start and stop services manually using systemctl and service.

```
muhammad@DESKTOP-HA2PTL5:~$ sudo systemctl start ssh
muhammad@DESKTOP-HA2PTL5:~$ sudo systemctl stop ssh
muhammad@DESKTOP-HA2PTL5:~$
```

3. Understanding Daemons

```
muhammad@DESKTOP-HA2PTL5:~$ sudo systemctl status ssh
○ ssh.service - OpenBSD Secure Shell server
     Loaded: loaded (/usr/lib/systemd/system/ssh.service; disabled; preset: enabled)
     Active: inactive (dead)
       Docs: man:sshd(8)
             man:sshd_config(5)

Apr 06 09:17:35 DESKTOP-HA2PTL5 systemd[1]: Starting ssh.service - OpenBSD Secure Shell server...
Apr 06 09:17:35 DESKTOP-HA2PTL5 sshd[777]: Server listening on 0.0.0.0 port 22.
Apr 06 09:17:35 DESKTOP-HA2PTL5 sshd[777]: Server listening on :: port 22.
Apr 06 09:17:35 DESKTOP-HA2PTL5 systemd[1]: Started ssh.service - OpenBSD Secure Shell server.
Apr 06 09:17:49 DESKTOP-HA2PTL5 sshd[777]: Received signal 15; terminating.
Apr 06 09:17:49 DESKTOP-HA2PTL5 systemd[1]: Stopping ssh.service - OpenBSD Secure Shell server...
Apr 06 09:17:49 DESKTOP-HA2PTL5 systemd[1]: ssh.service: Deactivated successfully.
Apr 06 09:17:49 DESKTOP-HA2PTL5 systemd[1]: Stopped ssh.service - OpenBSD Secure Shell server.
```

- Shows if the SSH service (daemon) is active, inactive, or failed.

4. Monitor Logs for Specific Service

➢ **View Logs for SSH:**

```
muhammad@DESKTOP-HA2PTL5:~$ sudo journalctl -u ssh
Mar 24 11:09:04 DESKTOP-HA2PTL5 systemd[1]: Starting ssh.service - OpenBSD Secure Shell server...
Mar 24 11:09:04 DESKTOP-HA2PTL5 sshd[1708]: Server listening on :: port 22.
Mar 24 11:09:04 DESKTOP-HA2PTL5 systemd[1]: Started ssh.service - OpenBSD Secure Shell server.
-- Boot 964b8a7242f349e19ec46999bb530857 --
Apr 06 08:48:48 DESKTOP-HA2PTL5 systemd[1]: Starting ssh.service - OpenBSD Secure Shell server...
Apr 06 08:48:48 DESKTOP-HA2PTL5 sshd[1288]: Server listening on :: port 22.
Apr 06 08:48:48 DESKTOP-HA2PTL5 systemd[1]: Started ssh.service - OpenBSD Secure Shell server.
Apr 06 08:51:17 DESKTOP-HA2PTL5 sshd[1301]: Accepted password for muhammad from 192.168.1.100 port 55966 ssh2
Apr 06 08:51:17 DESKTOP-HA2PTL5 sshd[1301]: pam_unix(sshd:session): session opened for user muhammad(uid=1000) by muham>
Apr 06 08:56:52 DESKTOP-HA2PTL5 sshd[1395]: Accepted password for muhammad from 192.168.1.100 port 59520 ssh2
Apr 06 08:56:52 DESKTOP-HA2PTL5 sshd[1395]: pam_unix(sshd:session): session opened for user muhammad(uid=1000) by muham>
Apr 06 08:56:54 DESKTOP-HA2PTL5 sshd[1395]: pam_unix(sshd:session): session closed for user muhammad
-- Boot 9deb7af9ff054a4cb1c7410fd51ffb83 --
Apr 06 09:17:35 DESKTOP-HA2PTL5 systemd[1]: Starting ssh.service - OpenBSD Secure Shell server...
Apr 06 09:17:35 DESKTOP-HA2PTL5 sshd[777]: Server listening on 0.0.0.0 port 22.
Apr 06 09:17:35 DESKTOP-HA2PTL5 sshd[777]: Server listening on :: port 22.
Apr 06 09:17:35 DESKTOP-HA2PTL5 systemd[1]: Started ssh.service - OpenBSD Secure Shell server.
Apr 06 09:17:49 DESKTOP-HA2PTL5 sshd[777]: Received signal 15; terminating.
Apr 06 09:17:49 DESKTOP-HA2PTL5 systemd[1]: Stopping ssh.service - OpenBSD Secure Shell server...
Apr 06 09:17:49 DESKTOP-HA2PTL5 systemd[1]: ssh.service: Deactivated successfully.
Apr 06 09:17:49 DESKTOP-HA2PTL5 systemd[1]: Stopped ssh.service - OpenBSD Secure Shell server.
```

- Shows all SSH-related logs.

➢ **Live Monitor SSH Logs:**

```
muhammad@DESKTOP-HA2PTL5:~$ sudo journalctl -u ssh -f
[sudo] password for muhammad:
Apr 06 09:17:35 DESKTOP-HA2PTL5 systemd[1]: Starting ssh.service - OpenBSD Secure Shell server...
Apr 06 09:17:35 DESKTOP-HA2PTL5 sshd[777]: Server listening on 0.0.0.0 port 22.
Apr 06 09:17:35 DESKTOP-HA2PTL5 sshd[777]: Server listening on :: port 22.
Apr 06 09:17:35 DESKTOP-HA2PTL5 systemd[1]: Started ssh.service - OpenBSD Secure Shell server.
Apr 06 09:17:49 DESKTOP-HA2PTL5 sshd[777]: Received signal 15; terminating.
Apr 06 09:17:49 DESKTOP-HA2PTL5 systemd[1]: Stopping ssh.service - OpenBSD Secure Shell server...
Apr 06 09:17:49 DESKTOP-HA2PTL5 systemd[1]: ssh.service: Deactivated successfully.
Apr 06 09:17:49 DESKTOP-HA2PTL5 systemd[1]: Stopped ssh.service - OpenBSD Secure Shell server.
```

- Displays SSH logs in real-time.

5. Review General System Logs

➢ **View Entire System Log:**

```
muhammad@DESKTOP-HA2PTL5:~$ sudo journalctl
[sudo] password for muhammad:
Mar 17 09:35:34 DESKTOP-HA2PTL5 kernel: Linux version 5.15.167.4-microsoft-standard-WSL2 (root@f9c826d3017f) (gcc (GCC)>
Mar 17 09:35:34 DESKTOP-HA2PTL5 kernel: Command line: initrd=\initrd.img WSL_ROOT_INIT=1 panic=-1 nr_cpus=8 hv_utils.ti>
Mar 17 09:35:34 DESKTOP-HA2PTL5 kernel: KERNEL supported cpus:
Mar 17 09:35:34 DESKTOP-HA2PTL5 kernel:   Intel GenuineIntel
Mar 17 09:35:34 DESKTOP-HA2PTL5 kernel:   AMD AuthenticAMD
Mar 17 09:35:34 DESKTOP-HA2PTL5 kernel:   Centaur CentaurHauls
Mar 17 09:35:34 DESKTOP-HA2PTL5 kernel: BIOS-provided physical RAM map:
Mar 17 09:35:34 DESKTOP-HA2PTL5 kernel: BIOS-e820: [mem 0x0000000000000000-0x000000000009ffff] usable
Mar 17 09:35:34 DESKTOP-HA2PTL5 kernel: BIOS-e820: [mem 0x00000000000e0000-0x00000000000e0fff] reserved
Mar 17 09:35:34 DESKTOP-HA2PTL5 kernel: BIOS-e820: [mem 0x0000000000100000-0x00000000001fffff] ACPI data
Mar 17 09:35:34 DESKTOP-HA2PTL5 kernel: BIOS-e820: [mem 0x0000000000200000-0x00000000f7ffffff] usable
Mar 17 09:35:34 DESKTOP-HA2PTL5 kernel: BIOS-e820: [mem 0x0000000100000000-0x0000000101dfffff] usable
Mar 17 09:35:34 DESKTOP-HA2PTL5 kernel: NX (Execute Disable) protection: active
Mar 17 09:35:34 DESKTOP-HA2PTL5 kernel: DMI not present or invalid.
Mar 17 09:35:34 DESKTOP-HA2PTL5 kernel: Hypervisor detected: Microsoft Hyper-V
Mar 17 09:35:34 DESKTOP-HA2PTL5 kernel: Hyper-V: privilege flags low 0x2e7f, high 0x3b8030, hints 0x924c2c, misc 0xe4be>
Mar 17 09:35:34 DESKTOP-HA2PTL5 kernel: Hyper-V Host Build:26100-10.0-3-0.3470
Mar 17 09:35:34 DESKTOP-HA2PTL5 kernel: Hyper-V: Nested features: 0x3e0101
Mar 17 09:35:34 DESKTOP-HA2PTL5 kernel: Hyper-V: LAPIC Timer Frequency: 0x1e8480
Mar 17 09:35:34 DESKTOP-HA2PTL5 kernel: Hyper-V: Using hypercall for remote TLB flush
Mar 17 09:35:34 DESKTOP-HA2PTL5 kernel: clocksource: hyperv_clocksource_tsc_page: mask: 0xffffffffffffffff max_cycles: >
Mar 17 09:35:34 DESKTOP-HA2PTL5 kernel: tsc: Marking TSC unstable due to running on Hyper-V
Mar 17 09:35:34 DESKTOP-HA2PTL5 kernel: tsc: Detected 1896.006 MHz processor
Mar 17 09:35:34 DESKTOP-HA2PTL5 kernel: e820: update [mem 0x00000000-0x00000fff] usable ==> reserved
Mar 17 09:35:34 DESKTOP-HA2PTL5 kernel: e820: remove [mem 0x000a0000-0x000fffff] usable
Mar 17 09:35:34 DESKTOP-HA2PTL5 kernel: last_pfn = 0x101e00 max_arch_pfn = 0x400000000
Mar 17 09:35:34 DESKTOP-HA2PTL5 kernel: x86/PAT: Configuration [0-7]: WB  WC  UC- UC  WB  WP  UC- WT
Mar 17 09:35:34 DESKTOP-HA2PTL5 kernel: last_pfn = 0xf8000 max_arch_pfn = 0x400000000
Mar 17 09:35:34 DESKTOP-HA2PTL5 kernel: Using GB pages for direct mapping
lines 1-29...skipping...
```

```
Mar 17 09:35:34 DESKTOP-HA2PTL5 kernel: Linux version 5.15.167.4-microsoft-standard-WSL2 (root@f9c826d3017f) (gcc (GCC) 11.2.0, GNU >
Mar 17 09:35:34 DESKTOP-HA2PTL5 kernel: Command line: initrd=\initrd.img WSL_ROOT_INIT=1 panic=-1 nr_cpus=8 hv_utils.timesync_implic>
Mar 17 09:35:34 DESKTOP-HA2PTL5 kernel: KERNEL supported cpus:
Mar 17 09:35:34 DESKTOP-HA2PTL5 kernel:   Intel GenuineIntel
Mar 17 09:35:34 DESKTOP-HA2PTL5 kernel:   AMD AuthenticAMD
Mar 17 09:35:34 DESKTOP-HA2PTL5 kernel:   Centaur CentaurHauls
Mar 17 09:35:34 DESKTOP-HA2PTL5 kernel: BIOS-provided physical RAM map:
Mar 17 09:35:34 DESKTOP-HA2PTL5 kernel: BIOS-e820: [mem 0x0000000000000000-0x000000000009ffff] usable
Mar 17 09:35:34 DESKTOP-HA2PTL5 kernel: BIOS-e820: [mem 0x00000000000e0000-0x00000000000e0fff] reserved
Mar 17 09:35:34 DESKTOP-HA2PTL5 kernel: BIOS-e820: [mem 0x0000000000100000-0x00000000001fffff] ACPI data
Mar 17 09:35:34 DESKTOP-HA2PTL5 kernel: BIOS-e820: [mem 0x0000000000200000-0x00000000f7ffffff] usable
Mar 17 09:35:34 DESKTOP-HA2PTL5 kernel: BIOS-e820: [mem 0x0000000100000000-0x0000000101dfffff] usable
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Mar 17 09:35:34 DESKTOP-HA2PTL5 kernel: DMI not present or invalid.
Mar 17 09:35:34 DESKTOP-HA2PTL5 kernel: Hypervisor detected: Microsoft Hyper-V
Mar 17 09:35:34 DESKTOP-HA2PTL5 kernel: Hyper-V: privilege flags low 0x2e7f, high 0x3b8030, hints 0x924c2c, misc 0xe4bed7b6
Mar 17 09:35:34 DESKTOP-HA2PTL5 kernel: Hyper-V Host Build:26100-10.0-3-0.3470
Mar 17 09:35:34 DESKTOP-HA2PTL5 kernel: Hyper-V: Nested features: 0x3e0101
Mar 17 09:35:34 DESKTOP-HA2PTL5 kernel: Hyper-V: LAPIC Timer Frequency: 0x1e8480
Mar 17 09:35:34 DESKTOP-HA2PTL5 kernel: Hyper-V: Using hypercall for remote TLB flush
Mar 17 09:35:34 DESKTOP-HA2PTL5 kernel: clocksource: hyperv_clocksource_tsc_page: mask: 0xffffffffffffffff max_cycles: 0x24e6a1710, >
Mar 17 09:35:34 DESKTOP-HA2PTL5 kernel: tsc: Marking TSC unstable due to running on Hyper-V
Mar 17 09:35:34 DESKTOP-HA2PTL5 kernel: tsc: Detected 1896.006 MHz processor
Mar 17 09:35:34 DESKTOP-HA2PTL5 kernel: e820: update [mem 0x00000000-0x00000fff] usable ==> reserved
Mar 17 09:35:34 DESKTOP-HA2PTL5 kernel: e820: remove [mem 0x000a0000-0x000fffff] usable
Mar 17 09:35:34 DESKTOP-HA2PTL5 kernel: last_pfn = 0x101e00 max_arch_pfn = 0x400000000
Mar 17 09:35:34 DESKTOP-HA2PTL5 kernel: x86/PAT: Configuration [0-7]: WB  WC  UC- UC  WB  WP  UC- WT
Mar 17 09:35:34 DESKTOP-HA2PTL5 kernel: last_pfn = 0xf8000 max_arch_pfn = 0x400000000
Mar 17 09:35:34 DESKTOP-HA2PTL5 kernel: Using GB pages for direct mapping
Mar 17 09:35:34 DESKTOP-HA2PTL5 kernel: RAMDISK: [mem 0x03de4000-0x04034fff]
Mar 17 09:35:34 DESKTOP-HA2PTL5 kernel: ACPI: Early table checksum verification disabled
```

- **View Logs Since Last Boot:**

```
muhammad@DESKTOP-HA2PTL5:~$ sudo journalctl -b
[sudo] password for muhammad:
Apr 06 09:09:04 DESKTOP-HA2PTL5 kernel: Linux version 5.15.167.4-microsoft-standard-WSL2 (root@f9c826d3017f) (gcc (GCC)>
Apr 06 09:09:04 DESKTOP-HA2PTL5 kernel: Command line: initrd=\initrd.img WSL_ROOT_INIT=1 panic=-1 nr_cpus=8 hv_utils.ti>
Apr 06 09:09:04 DESKTOP-HA2PTL5 kernel: KERNEL supported cpus:
Apr 06 09:09:04 DESKTOP-HA2PTL5 kernel:   Intel GenuineIntel
Apr 06 09:09:04 DESKTOP-HA2PTL5 kernel:   AMD AuthenticAMD
Apr 06 09:09:04 DESKTOP-HA2PTL5 kernel:   Centaur CentaurHauls
Apr 06 09:09:04 DESKTOP-HA2PTL5 kernel: BIOS-provided physical RAM map:
Apr 06 09:09:04 DESKTOP-HA2PTL5 kernel: BIOS-e820: [mem 0x0000000000000000-0x000000000009ffff] usable
Apr 06 09:09:04 DESKTOP-HA2PTL5 kernel: BIOS-e820: [mem 0x00000000000e0000-0x00000000000e0fff] reserved
Apr 06 09:09:04 DESKTOP-HA2PTL5 kernel: BIOS-e820: [mem 0x0000000000100000-0x00000000001fffff] ACPI data
Apr 06 09:09:04 DESKTOP-HA2PTL5 kernel: BIOS-e820: [mem 0x0000000000200000-0x00000000f7ffffff] usable
Apr 06 09:09:04 DESKTOP-HA2PTL5 kernel: BIOS-e820: [mem 0x0000000100000000-0x0000000101dfffff] usable
Apr 06 09:09:04 DESKTOP-HA2PTL5 kernel: NX (Execute Disable) protection: active
Apr 06 09:09:04 DESKTOP-HA2PTL5 kernel: DMI not present or invalid.
Apr 06 09:09:04 DESKTOP-HA2PTL5 kernel: Hypervisor detected: Microsoft Hyper-V
Apr 06 09:09:04 DESKTOP-HA2PTL5 kernel: Hyper-V: privilege flags low 0x2e7f, high 0x3b8030, hints 0x924c2c, misc 0xe4be>
Apr 06 09:09:04 DESKTOP-HA2PTL5 kernel: Hyper-V Host Build:26100-10.0-3-0.3624
Apr 06 09:09:04 DESKTOP-HA2PTL5 kernel: Hyper-V: Nested features: 0x3e0101
Apr 06 09:09:04 DESKTOP-HA2PTL5 kernel: Hyper-V: LAPIC Timer Frequency: 0x1e8480
Apr 06 09:09:04 DESKTOP-HA2PTL5 kernel: Hyper-V: Using hypercall for remote TLB flush
Apr 06 09:09:04 DESKTOP-HA2PTL5 kernel: clocksource: hyperv_clocksource_tsc_page: mask: 0xffffffffffffffff max_cycles: >
Apr 06 09:09:04 DESKTOP-HA2PTL5 kernel: tsc: Marking TSC unstable due to running on Hyper-V
Apr 06 09:09:04 DESKTOP-HA2PTL5 kernel: tsc: Detected 1896.005 MHz processor
Apr 06 09:09:04 DESKTOP-HA2PTL5 kernel: e820: update [mem 0x00000000-0x00000fff] usable ==> reserved
Apr 06 09:09:04 DESKTOP-HA2PTL5 kernel: e820: remove [mem 0x000a0000-0x000fffff] usable
Apr 06 09:09:04 DESKTOP-HA2PTL5 kernel: last_pfn = 0x101e00 max_arch_pfn = 0x400000000
Apr 06 09:09:04 DESKTOP-HA2PTL5 kernel: x86/PAT: Configuration [0-7]: WB  WC  UC- UC  WB  WP  UC- WT
Apr 06 09:09:04 DESKTOP-HA2PTL5 kernel: last_pfn = 0xf8000 max_arch_pfn = 0x400000000
Apr 06 09:09:04 DESKTOP-HA2PTL5 kernel: Using GB pages for direct mapping
lines 1-29...skipping...
Apr 06 09:09:04 DESKTOP-HA2PTL5 kernel: Linux version 5.15.167.4-microsoft-standard-WSL2 (root@f9c826d3017f) (gcc (GCC) 11.2.0, GNU >
```

GENERALIZED LAB RUBRICS

Domain	Component with Taxonomy	Above Expectation (4)	Meeting Expectation (3)	Approaching Expectation (2)	Below Expectation (1)	Used	Weight / 100 (Optional)	Score (1–4)
Psychomotor	**Building (**Hardware)	Is able to build a given setup neatly and timely using correct hardware components and / or can reorganize / adapt to new / special requirements	Is able to assemble a given setup using correct hardware components after minor revisions	Is only able to copy a given setup using correct hardware components	Is not able to assemble a given setup using correct hardware components	☐		
Cognitive	**Recording Measurements** (Hardware / Software)	Is able to record accurate measurements all the time	Is able to record accurate measurements most of the time	Is only able to record accurate measurements on some occasions	Is unable to record accurate measurements	☐		
	Investigation (Software)	Is able to formulate /develop theories in addition to evaluating /concluding correctly about investigation parameters by assessing data	Is able to evaluate /conclude correctly about investigation parameters by assessing data	Is partially able to evaluate /conclude correctly about investigation parameters by assessing data	Is unable to comprehend investigation parameters	☐		
	Design / Development of Solution (Hardware / Software)	Is able to design / develop the solution of a given problem and add features to it	Is able to design / develop the solution of a given problem	Is able to partially design / develop the solution of a given problem	Is unable to partially design / develop the solution of a given problem	☐		
	Software Usage (Software)	Is adept in the use of software tool and can access advanced features	Is able to use the software tool effectively by accessing all the required features	Is able to use the software tool but cannot access all the required features	Is unable to use the software tool	☐		
	Programming Language (Software)	Is able to efficiently complete a given task using advanced programming language constructs / methods / commands and/or add features to the original task	Is able to complete a given task using required programming language constructs / methods / commands	Is able to partially complete a given task	Is unable to partially complete a given task	☐		

GENERALIZED LAB RUBRICS

Domain	Component with Taxonomy	Above Expectation (4)	Meeting Expectation (3)	Approaching Expectation (2)	Below Expectation (1)	Used	Weight / 100 (Optional)	Score (1–4)
Affective	**Safety Instructions (PLO6)**	Assesses and complies with all EHS instructions while in lab	Assesses and complies with most EHS instructions while in lab	Assesses and complies with some EHS instructions while in lab	Assesses and complies with few EHS instructions in lab	☐		
	Professional Ethics (PLO8)	Exhibits exemplary professional ethics while writing lab reports and dealing with fellow students, lab staff and instructor all the time	Exhibits professional ethics while writing lab reports and dealing with fellow students, lab staff and instructor all the time	Makes an effort to exhibit professional ethics while writing lab reports and dealing with fellow students, lab staff and instructor all the time	Does not exhibit professional ethics while writing lab reports and dealing with fellow students, lab staff and instructor all the time	☐		
	Contribution (PLO9)	Consistently shows full preparation by completing all agreed tasks and provides additional resources for the group and work quality is excellent	Consistently shows full preparation by completing all agreed tasks and work requires little or no revisions	Shows some preparation which is mostly at superficial level in completing a task and work requires much revisions and editing	Shows very little or no preparation in completing a task and work quality is poor	☐		
	Attitude (PLO9)	Internalized positive behavior and encourages and helps other team members	Consistent positive behavior most of the time towards other team members	Neither helpful nor damaging and shows disinterest in the performance of others	Discouraging behavior towards other team members	☐		
	Report Writing (PLO10)	Report on all relevant sections related to the lab tasks is completed accurately, meeting the requirements, in prescribed time and with good language skills	Report on all relevant sections related to the lab tasks is completed but few deficiencies are present in terms of accuracy / meeting the requirements / prescribed time / good language skills	Report on all relevant sections related to the lab tasks is completed but many deficiencies are present in terms of accuracy / meeting the requirements / prescribed time / good language skills	Report on all relevant sections related to the lab tasks is not completed	☐		
	Lab Task Management (PLO11)	Manages tasks well within given timeframe	Manages tasks within given timeframe	Manages tasks in an extended timeframe	Does not manage tasks even in extended timeframes	☐		

Lab 12: Firewall and Security

Objective: Learn basic Linux security.

Topics:

- Using `iptables` and `ufw`.

- Securing SSH access.

- File encryption using `gpg`.

Tasks:

- Block and allow specific ports using `ufw`.

- Set up SSH key-based authentication.

Solution:

Task 1: Configure Firewall using UFW

Step 1: Enable UFW

```
khubaib@DESKTOP-HA2PTL5:~$ sudo ufw enable
Firewall is active and enabled on system startup
```

Step 2: Check Firewall Status

```
khubaib@DESKTOP-HA2PTL5:~$ sudo ufw status verbose
Status: active
Logging: on (low)
Default: deny (incoming), allow (outgoing), disabled (routed)
New profiles: skip
```

Step 3: Allow Specific Port (e.g., SSH - Port 22)

```
khubaib@DESKTOP-HA2PTL5:~$ sudo ufw allow 22
Rule added
Rule added (v6)
```

Step 4: Block a Port (e.g., HTTP - Port 80)

```
khubaib@DESKTOP-HA2PTL5:~$ sudo ufw deny 80
Rule added
Rule added (v6)
```

Step 5: Delete a Rule (Optional)

```
khubaib@DESKTOP-HA2PTL5:~$ sudo ufw delete allow 22
Rule deleted
Rule deleted (v6)
khubaib@DESKTOP-HA2PTL5:~$
```

Task 2: SSH Key-Based Authentication

Note: SSH server might not run directly on WSL. You can still create keys and understand the configuration.

Step 1: Generate SSH Key Pair

```
khubaib@DESKTOP-HA2PTL5:~$ ssh-keygen -t rsa -b 4096
Generating public/private rsa key pair.
Enter file in which to save the key (/home/khubaib/.ssh/id_rsa):
Created directory '/home/khubaib/.ssh'.
Enter passphrase (empty for no passphrase):
Enter same passphrase again:
Your identification has been saved in /home/khubaib/.ssh/id_rsa
Your public key has been saved in /home/khubaib/.ssh/id_rsa.pub
The key fingerprint is:
SHA256:j/4kdcBb99XjUUfC6/4AsG+4xcFIYY6Ivz1peFYxwv8 khubaib@DESKTOP-HA2PTL5
The key's randomart image is:
+---[RSA 4096]----+
|          o  ...+|
|     . o = .  ..+|
|    . . + O . .+o|
|     .   + @ .o.+|
|      . S B =. ..|
|       + * * o.  |
|      o X + E..  |
|       = + +  .. |
|        ..o    ..|
+----[SHA256]-----+
```

Step 2: View the Public Key

```
khubaib@DESKTOP-HA2PTL5:~$ cat ~/.ssh/id_rsa.pub
ssh-rsa AAAAB3NzaC1yc2EAAAADAQABAAACAQD9JLDzhoB/3UHWiqhAHZG8S8uhVqsYGxtK+8S7zQFnVGGexrvoHTw4tpGNm49jjuvq8fLqiR2PRMg3qInx+e4eYkL6rQMPJ
dm5T5k0QvgwAppBm507uPPaGos6csOd7rA1R1fSMi3EMMJImyuYy9BZ0Ay6c9yq6evh1o0HOJUtK3+5DRTZ4pUFrm6uTSxWz7MZMqYW7gB8aKK1q6UR7uBzFlaXTtipch/qkO
gkLaCZPcPxGs0A9K1+75w0Cq3J8ldcUcJ75EaEm14mD7QvbQzUsZoASkQwH2ZvcO5rrFx7Gk4x/IlaLtC4WY5NuXEQI5hFpml9/lsxkYibU84jecgf6PYZPMhvBGu6YOPqxZl
2FSHGooQFbNVaKExhLNqf9zyj7h1uPz/MWxiCto0/ePIrksrp+GJidwUX5tJvZmwiLtlMPNI0ogAasa52nhS1EYJBkNpSVUgxE/u7x4Sh5east/6MNQGLNuiXlAojVCAtF/RB
i020iWZZH4JJ3bp+Npv5BFYywUYwPQc4V0moZ16C4mwk2MtX7nEwU04narRMhadkOhBcPDThu1wqf1xy2bFIDyMeUMgV9PS+pujdyTcffCIWckavPSw6GOs+Dq7tfK0kx/475
eMbEpRB7m1emUDG6kykso7KFF2L+jRAts/9ImXGMeaub6EwBh2TDpUc9w== khubaib@DESKTOP-HA2PTL5
```

Step 3: Copy the Public Key to Remote Server

```
khubaib@DESKTOP-HA2PTL5:~$ ssh-copy-id khubaib@192.168.1.10
/usr/bin/ssh-copy-id: INFO: Source of key(s) to be installed: "/home/khubaib/.ssh/id_rsa.pub"
/usr/bin/ssh-copy-id: INFO: attempting to log in with the new key(s), to filter out any that are already installed

/usr/bin/ssh-copy-id: ERROR: ssh: connect to host 192.168.1.10 port 22: Connection timed out
```

Step 4: Disable Password Authentication (on remote server)

```
khubaib@DESKTOP-HA2PTL5:~$ sudo nano /etc/ssh/sshd_config
khubaib@DESKTOP-HA2PTL5:~$ sudo service ssh restart
khubaib@DESKTOP-HA2PTL5:~$
```

Task 3: Encrypt and Decrypt Files using GPG

Step 1: Install GPG (if not installed)

```
khubaib@DESKTOP-HA2PTL5:~$ sudo apt install gnupg
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
gnupg is already the newest version (2.4.4-2ubuntu17.2).
gnupg set to manually installed.
The following package was automatically installed and is no longer required:
  libllvm17t64
Use 'sudo apt autoremove' to remove it.
0 upgraded, 0 newly installed, 0 to remove and 0 not upgraded.
```

Step 2: Create a File to Encrypt

```
khubaib@DESKTOP-HA2PTL5:~$ echo "This is secret data." > secret.txt
```

Step 3: Encrypt the File

```
khubaib@DESKTOP-HA2PTL5:~$ gpg -c secret.txt
gpg: directory '/home/khubaib/.gnupg' created
gpg: keybox '/home/khubaib/.gnupg/pubring.kbx' created
khubaib@DESKTOP-HA2PTL5:~$
```

Step 4: Decrypt the File

```
khubaib@DESKTOP-HA2PTL5:~$ gpg secret.txt.gpg
gpg: WARNING: no command supplied.  Trying to guess what you mean ...
gpg: AES256.CFB encrypted data
gpg: encrypted with 1 passphrase
File 'secret.txt' exists. Overwrite? (y/N) y
khubaib@DESKTOP-HA2PTL5:~$
```

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	Contribution (PLO9)	Consistently shows full preparation by completing all agreed tasks and provides additional resources for the group and work quality is excellent	Consistently shows full preparation by completing all agreed tasks and work requires little or no revisions	Shows some preparation which is mostly at superficial level in completing a task and work requires much revisions and editing	Shows very little or no preparation in completing a task and work quality is poor	☐		
	Attitude (PLO9)	Internalized positive behavior and encourages and helps other team members	Consistent positive behavior most of the time towards other team members	Neither helpful nor damaging and shows disinterest in the performance of others	Discouraging behavior towards other team members	☐		
	Report Writing (PLO10)	Report on all relevant sections related to the lab tasks is completed accurately, meeting the requirements, in prescribed time and with good language skills	Report on all relevant sections related to the lab tasks is completed but few deficiencies are present in terms of accuracy / meeting the requirements / prescribed time / good language skills	Report on all relevant sections related to the lab tasks is completed but many deficiencies are present in terms of accuracy / meeting the requirements / prescribed time / good language skills	Report on all relevant sections related to the lab tasks is not completed	☐		
	Lab Task Management (PLO11)	Manages tasks well within given timeframe	Manages tasks within given timeframe	Manages tasks in an extended timeframe	Does not manage tasks even in extended timeframes	☐		

Lab 13: Virtualization with Linux

Objective:

Set up and use virtualization tools.

Topics:

- Installing and using VirtualBox or KVM.

- Creating virtual machines.

- Managing snapshots.

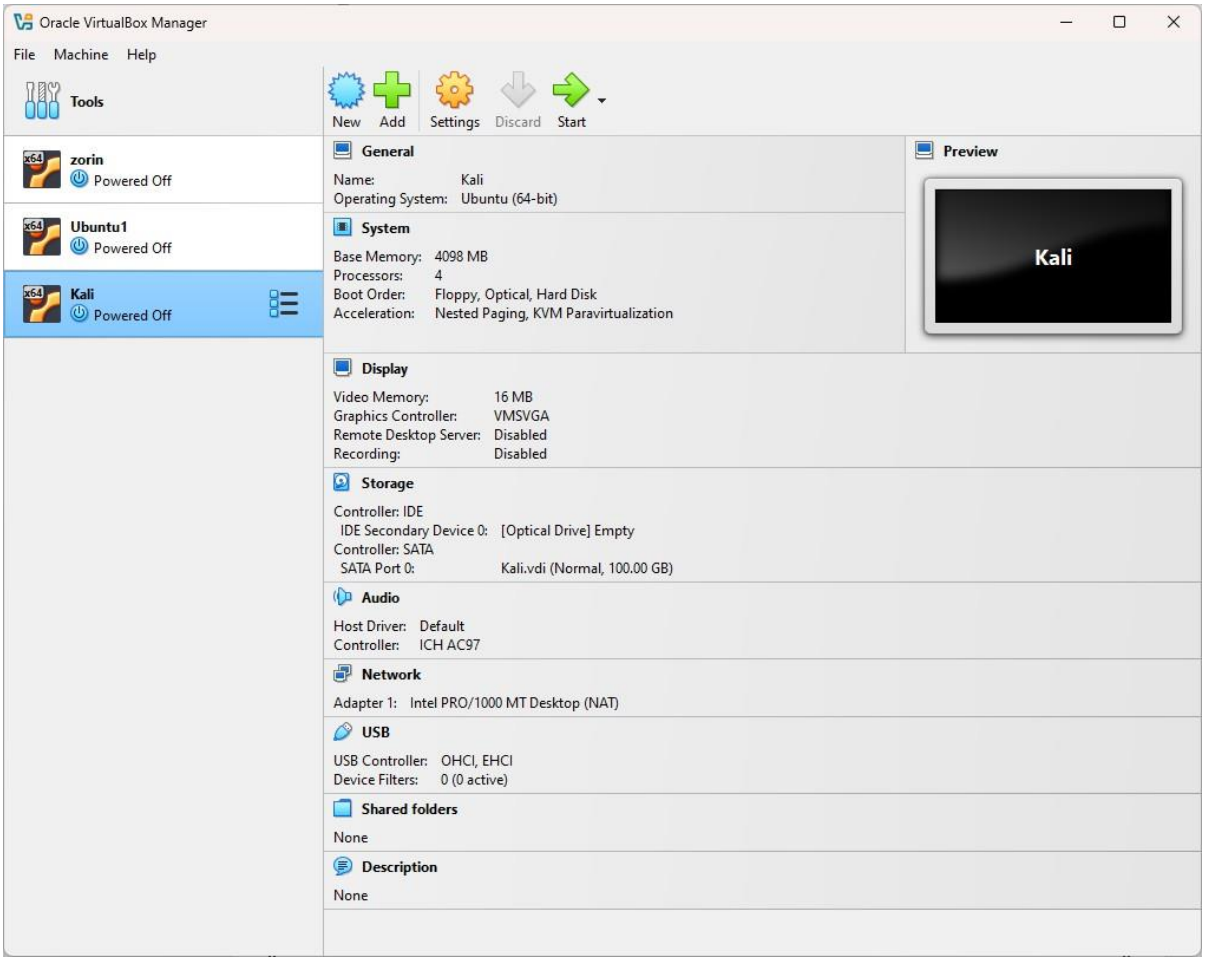
Tasks:

- Install and configure a Linux VM.

- Test snapshots and rollbacks.

Solution:

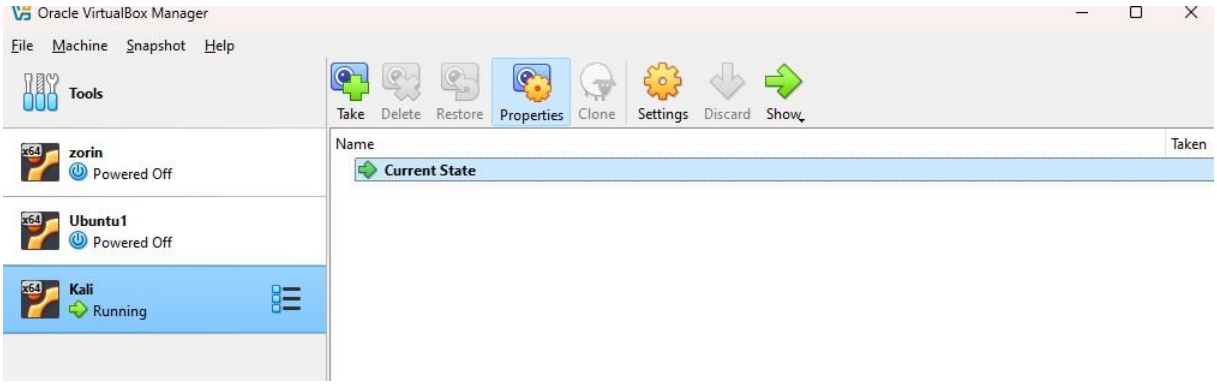
- Well, I am using virtual Box for a while so in this I will tell the steps to install virtual box by Oracle by going to their official website: https://www.virtualbox.org/wiki/Downloads.
- an interface like this will pop up after installation:



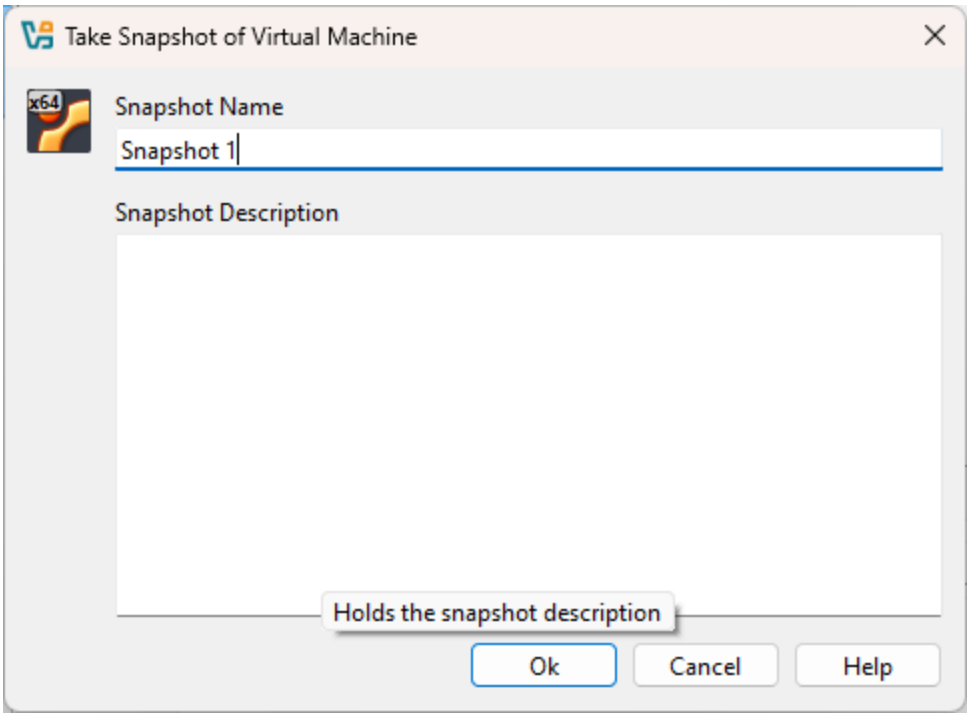
- As I have told above, I have been using virtual box for a while that's why you can see three different systems already integrated in the VM (Zorin, Ubuntu1, Kali).
- we can add as many OS systems in VMs by clicking on the add or new button on top menu bar.
    1. We can use add option when we have disk image for the operating system.
    2. New is used to install operating system using iso file.

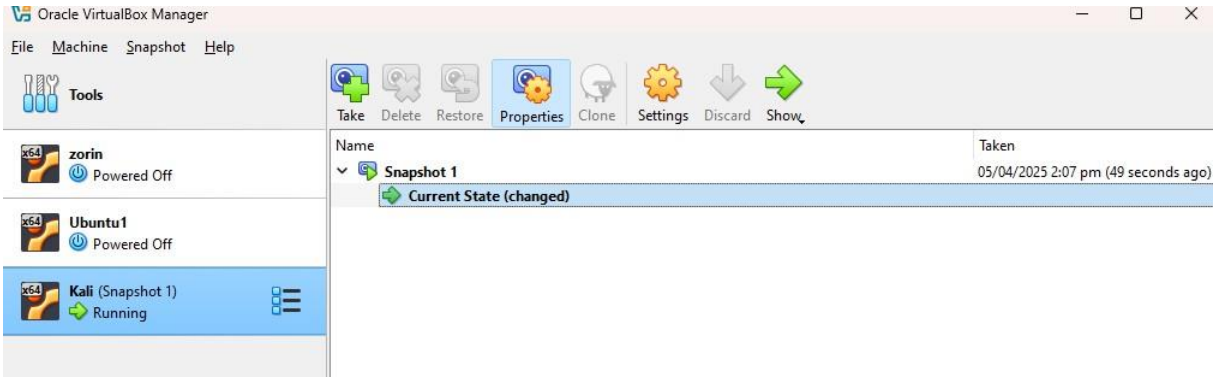
Now I am going to test snapshot and rollback.:

As you can see there is no snapshot currently, first let's create a snapshot by clicking on 'take' in the top menu.

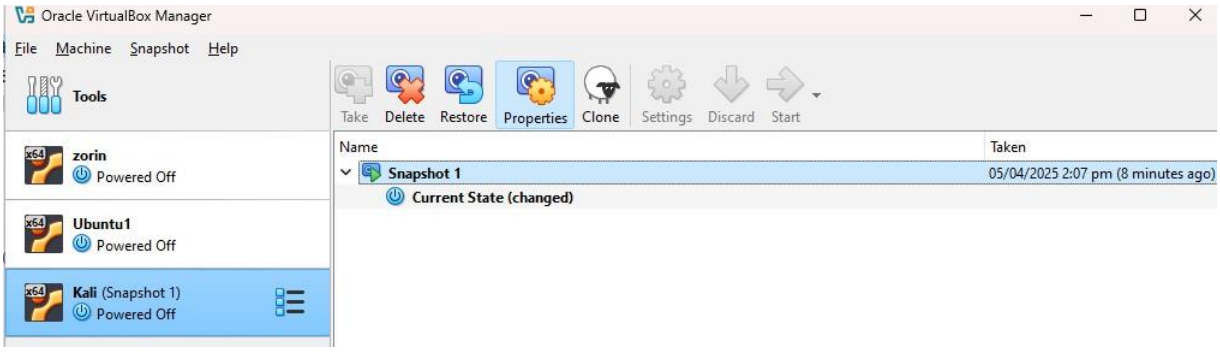


At the time of snapshot I have above files in my system.

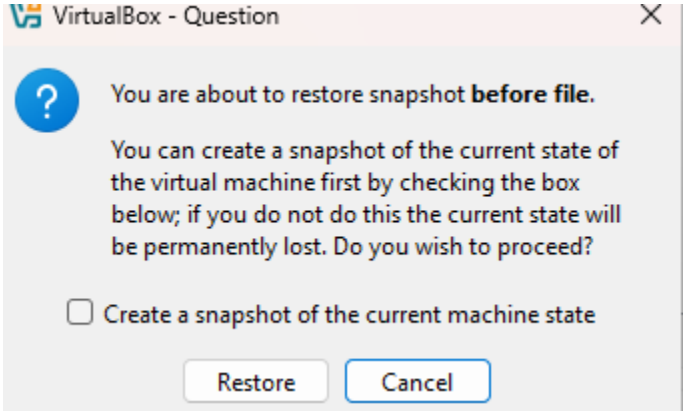


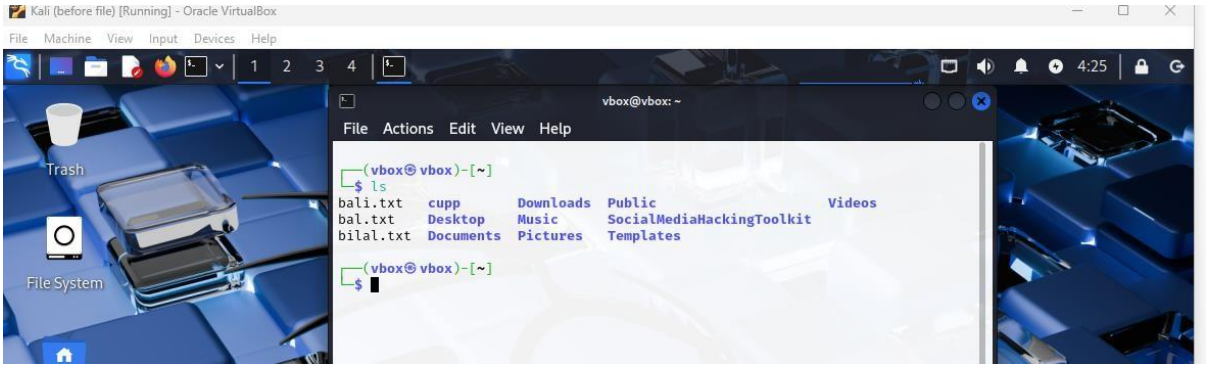


Now we have successfully created a snapshot let's make some changes to test the rollback: I am going to create a txt file "test.txt" to make a change in the system after snapshot.



Now to do a rollback first power off the system and click on the snapshot that we have created before creating “test.txt” file.





As you can see the system is rollback to the time before the “test.txt” was created.

GENERALIZED LAB RUBRICS

Domain	Component with Taxonomy	Above Expectation (4)	Meeting Expectation (3)	Approaching Expectation (2)	Below Expectation (1)	Used	Weight / 100 (Optional)	Score (1–4)
Psychomotor	**Building (**Hardware)	Is able to build a given setup neatly and timely using correct hardware components and / or can reorganize / adapt to new / special requirements	Is able to assemble a given setup using correct hardware components after minor revisions	Is only able to copy a given setup using correct hardware components	Is not able to assemble a given setup using correct hardware components	☐		
Cognitive	**Recording Measurements** (Hardware / Software)	Is able to record accurate measurements all the time	Is able to record accurate measurements most of the time	Is only able to record accurate measurements on some occasions	Is unable to record accurate measurements	☐		
	Investigation (Software)	Is able to formulate /develop theories in addition to evaluating /concluding correctly about investigation parameters by assessing data	Is able to evaluate /conclude correctly about investigation parameters by assessing data	Is partially able to evaluate /conclude correctly about investigation parameters by assessing data	Is unable to comprehend investigation parameters	☐		
	Design / Development of Solution (Hardware / Software)	Is able to design / develop the solution of a given problem and add features to it	Is able to design / develop the solution of a given problem	Is able to partially design / develop the solution of a given problem	Is unable to partially design / develop the solution of a given problem	☐		
	Software Usage (Software)	Is adept in the use of software tool and can access advanced features	Is able to use the software tool effectively by accessing all the required features	Is able to use the software tool but cannot access all the required features	Is unable to use the software tool	☐		
	Programming Language (Software)	Is able to efficiently complete a given task using advanced programming language constructs / methods / commands and/or add features to the original task	Is able to complete a given task using required programming language constructs / methods / commands	Is able to partially complete a given task	Is unable to partially complete a given task	☐		

GENERALIZED LAB RUBRICS

Domain	Component with Taxonomy	Above Expectation (4)	Meeting Expectation (3)	Approaching Expectation (2)	Below Expectation (1)	Used	Weight / 100 (Optional)	Score (1–4)
Affective	**Safety Instructions (PLO6)**	Assesses and complies with all EHS instructions while in lab	Assesses and complies with most EHS instructions while in lab	Assesses and complies with some EHS instructions while in lab	Assesses and complies with few EHS instructions in lab	☐		
	Professional Ethics (PLO8)	Exhibits exemplary professional ethics while writing lab reports and dealing with fellow students, lab staff and instructor all the time	Exhibits professional ethics while writing lab reports and dealing with fellow students, lab staff and instructor all the time	Makes an effort to exhibit professional ethics while writing lab reports and dealing with fellow students, lab staff and instructor all the time	Does not exhibit professional ethics while writing lab reports and dealing with fellow students, lab staff and instructor all the time	☐		
	Contribution (PLO9)	Consistently shows full preparation by completing all agreed tasks and provides additional resources for the group and work quality is excellent	Consistently shows full preparation by completing all agreed tasks and work requires little or no revisions	Shows some preparation which is mostly at superficial level in completing a task and work requires much revisions and editing	Shows very little or no preparation in completing a task and work quality is poor	☐		
	Attitude (PLO9)	Internalized positive behavior and encourages and helps other team members	Consistent positive behavior most of the time towards other team members	Neither helpful nor damaging and shows disinterest in the performance of others	Discouraging behavior towards other team members	☐		
	Report Writing (PLO10)	Report on all relevant sections related to the lab tasks is completed accurately, meeting the requirements, in prescribed time and with good language skills	Report on all relevant sections related to the lab tasks is completed but few deficiencies are present in terms of accuracy / meeting the requirements / prescribed time / good language skills	Report on all relevant sections related to the lab tasks is completed but many deficiencies are present in terms of accuracy / meeting the requirements / prescribed time / good language skills	Report on all relevant sections related to the lab tasks is not completed	☐		
	Lab Task Management (PLO11)	Manages tasks well within given timeframe	Manages tasks within given timeframe	Manages tasks in an extended timeframe	Does not manage tasks even in extended timeframes	☐		

Lab 14: Performance Monitoring

Objective:

Monitor system performance and troubleshoot

Topics:

- Using 'top', 'htop', 'iotop'.

- Monitoring disk I/O and memory usage.

- Checking logs for errors.

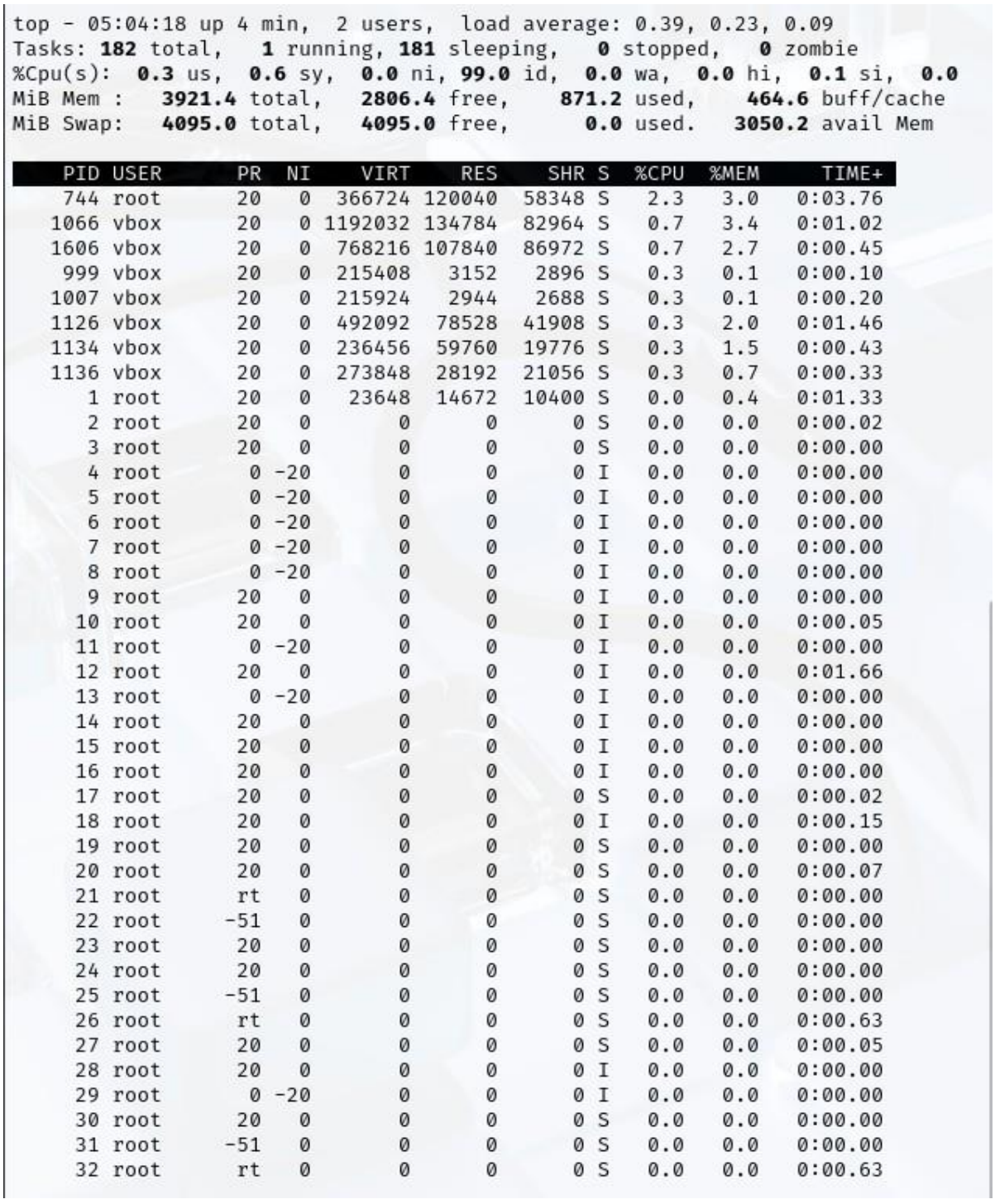
Tasks:

- Analyze system bottlenecks.

- Write a report on system performance.

Solution:

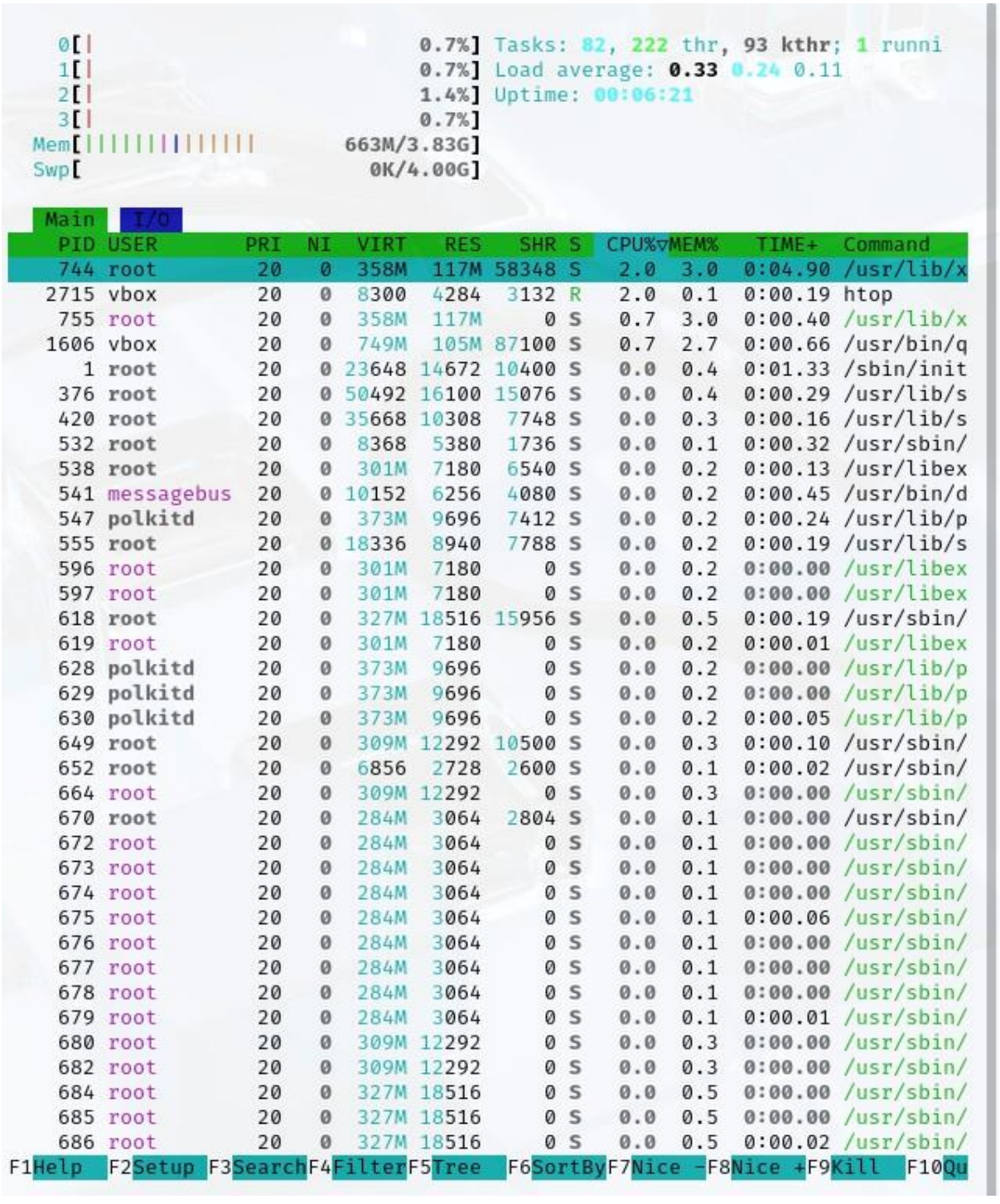
Checking system stats using top:



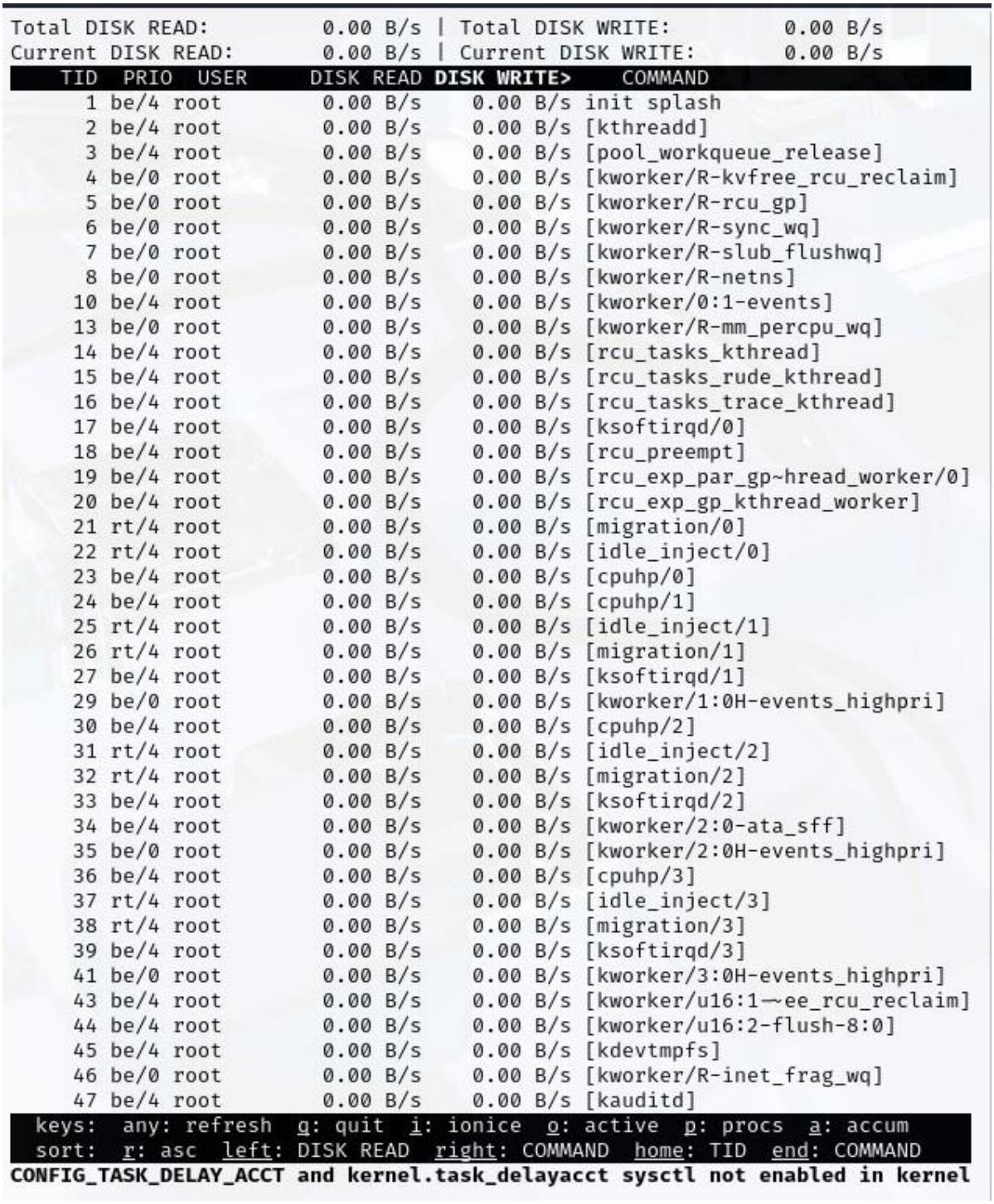
```
top - 05:04:18 up 4 min,  2 users,  load average: 0.39, 0.23, 0.09
Tasks: 182 total,   1 running, 181 sleeping,   0 stopped,   0 zombie
%Cpu(s):  0.3 us,  0.6 sy,  0.0 ni, 99.0 id,  0.0 wa,  0.0 hi,  0.1 si,  0.0
MiB Mem :   3921.4 total,   2806.4 free,    871.2 used,    464.6 buff/cache
MiB Swap:   4095.0 total,   4095.0 free,      0.0 used.   3050.2 avail Mem

    PID USER      PR  NI    VIRT    RES    SHR S  %CPU  %MEM     TIME+
    744 root      20   0  366724 120040  58348 S   2.3   3.0   0:03.76
   1066 vbox      20   0 1192032 134784  82964 S   0.7   3.4   0:01.02
   1606 vbox      20   0  768216 107840  86972 S   0.7   2.7   0:00.45
    999 vbox      20   0  215408   3152   2896 S   0.3   0.1   0:00.10
   1007 vbox      20   0  215924   2944   2688 S   0.3   0.1   0:00.20
   1126 vbox      20   0  492092  78528  41908 S   0.3   2.0   0:01.46
   1134 vbox      20   0  236456  59760  19776 S   0.3   1.5   0:00.43
   1136 vbox      20   0  273848  28192  21056 S   0.3   0.7   0:00.33
      1 root      20   0   23648  14672  10400 S   0.0   0.4   0:01.33
      2 root      20   0       0      0      0 S   0.0   0.0   0:00.02
      3 root      20   0       0      0      0 S   0.0   0.0   0:00.00
      4 root       0 -20       0      0      0 I   0.0   0.0   0:00.00
      5 root       0 -20       0      0      0 I   0.0   0.0   0:00.00
      6 root       0 -20       0      0      0 I   0.0   0.0   0:00.00
      7 root       0 -20       0      0      0 I   0.0   0.0   0:00.00
      8 root       0 -20       0      0      0 I   0.0   0.0   0:00.00
      9 root      20   0       0      0      0 I   0.0   0.0   0:00.00
     10 root      20   0       0      0      0 I   0.0   0.0   0:00.05
     11 root       0 -20       0      0      0 I   0.0   0.0   0:00.00
     12 root      20   0       0      0      0 I   0.0   0.0   0:01.66
     13 root       0 -20       0      0      0 I   0.0   0.0   0:00.00
     14 root      20   0       0      0      0 I   0.0   0.0   0:00.00
     15 root      20   0       0      0      0 I   0.0   0.0   0:00.00
     16 root      20   0       0      0      0 I   0.0   0.0   0:00.00
     17 root      20   0       0      0      0 S   0.0   0.0   0:00.02
     18 root      20   0       0      0      0 I   0.0   0.0   0:00.15
     19 root      20   0       0      0      0 S   0.0   0.0   0:00.00
     20 root      20   0       0      0      0 S   0.0   0.0   0:00.07
     21 root      rt   0       0      0      0 S   0.0   0.0   0:00.00
     22 root     -51   0       0      0      0 S   0.0   0.0   0:00.00
     23 root      20   0       0      0      0 S   0.0   0.0   0:00.00
     24 root      20   0       0      0      0 S   0.0   0.0   0:00.00
     25 root     -51   0       0      0      0 S   0.0   0.0   0:00.00
     26 root      rt   0       0      0      0 S   0.0   0.0   0:00.63
     27 root      20   0       0      0      0 S   0.0   0.0   0:00.05
     28 root      20   0       0      0      0 I   0.0   0.0   0:00.00
     29 root       0 -20       0      0      0 I   0.0   0.0   0:00.00
     30 root      20   0       0      0      0 S   0.0   0.0   0:00.00
     31 root     -51   0       0      0      0 S   0.0   0.0   0:00.00
     32 root      rt   0       0      0      0 S   0.0   0.0   0:00.63
```

Checking system stats using htop:



Checking system stats using iotop:



```
Total DISK READ:         0.00 B/s | Total DISK WRITE:         0.00 B/s
Current DISK READ:       0.00 B/s | Current DISK WRITE:       0.00 B/s
    TID  PRIO  USER     DISK READ  DISK WRITE>    COMMAND
      1 be/4 root        0.00 B/s    0.00 B/s init splash
      2 be/4 root        0.00 B/s    0.00 B/s [kthreadd]
      3 be/4 root        0.00 B/s    0.00 B/s [pool_workqueue_release]
      4 be/0 root        0.00 B/s    0.00 B/s [kworker/R-kvfree_rcu_reclaim]
      5 be/0 root        0.00 B/s    0.00 B/s [kworker/R-rcu_gp]
      6 be/0 root        0.00 B/s    0.00 B/s [kworker/R-sync_wq]
      7 be/0 root        0.00 B/s    0.00 B/s [kworker/R-slub_flushwq]
      8 be/0 root        0.00 B/s    0.00 B/s [kworker/R-netns]
     10 be/4 root        0.00 B/s    0.00 B/s [kworker/0:1-events]
     13 be/0 root        0.00 B/s    0.00 B/s [kworker/R-mm_percpu_wq]
     14 be/4 root        0.00 B/s    0.00 B/s [rcu_tasks_kthread]
     15 be/4 root        0.00 B/s    0.00 B/s [rcu_tasks_rude_kthread]
     16 be/4 root        0.00 B/s    0.00 B/s [rcu_tasks_trace_kthread]
     17 be/4 root        0.00 B/s    0.00 B/s [ksoftirqd/0]
     18 be/4 root        0.00 B/s    0.00 B/s [rcu_preempt]
     19 be/4 root        0.00 B/s    0.00 B/s [rcu_exp_par_gp~hread_worker/0]
     20 be/4 root        0.00 B/s    0.00 B/s [rcu_exp_gp_kthread_worker]
     21 rt/4 root        0.00 B/s    0.00 B/s [migration/0]
     22 rt/4 root        0.00 B/s    0.00 B/s [idle_inject/0]
     23 be/4 root        0.00 B/s    0.00 B/s [cpuhp/0]
     24 be/4 root        0.00 B/s    0.00 B/s [cpuhp/1]
     25 rt/4 root        0.00 B/s    0.00 B/s [idle_inject/1]
     26 rt/4 root        0.00 B/s    0.00 B/s [migration/1]
     27 be/4 root        0.00 B/s    0.00 B/s [ksoftirqd/1]
     29 be/0 root        0.00 B/s    0.00 B/s [kworker/1:0H-events_highpri]
     30 be/4 root        0.00 B/s    0.00 B/s [cpuhp/2]
     31 rt/4 root        0.00 B/s    0.00 B/s [idle_inject/2]
     32 rt/4 root        0.00 B/s    0.00 B/s [migration/2]
     33 be/4 root        0.00 B/s    0.00 B/s [ksoftirqd/2]
     34 be/4 root        0.00 B/s    0.00 B/s [kworker/2:0-ata_sff]
     35 be/0 root        0.00 B/s    0.00 B/s [kworker/2:0H-events_highpri]
     36 be/4 root        0.00 B/s    0.00 B/s [cpuhp/3]
     37 rt/4 root        0.00 B/s    0.00 B/s [idle_inject/3]
     38 rt/4 root        0.00 B/s    0.00 B/s [migration/3]
     39 be/4 root        0.00 B/s    0.00 B/s [ksoftirqd/3]
     41 be/0 root        0.00 B/s    0.00 B/s [kworker/3:0H-events_highpri]
     43 be/4 root        0.00 B/s    0.00 B/s [kworker/u16:1~ee_rcu_reclaim]
     44 be/4 root        0.00 B/s    0.00 B/s [kworker/u16:2-flush-8:0]
     45 be/4 root        0.00 B/s    0.00 B/s [kdevtmpfs]
     46 be/0 root        0.00 B/s    0.00 B/s [kworker/R-inet_frag_wq]
     47 be/4 root        0.00 B/s    0.00 B/s [kauditd]
  keys:  any: refresh  q: quit  i: ionice  o: active  p: procs  a: accum
  sort:  r: asc  left: DISK READ  right: COMMAND  home: TID  end: COMMAND
CONFIG_TASK_DELAY_ACCT and kernel.task_delayacct sysctl not enabled in kernel
```

Checking system stats logs using systemctl for specific errors:

```
┌──(vbox㉿vbox)-[~]
└─$ sudo journalctl -p 3 -xb
Apr 05 04:59:37 vbox kernel: vmwgfx 0000:00:02.0: [drm] *ERROR* vmwgfx seems>
Apr 05 04:59:37 vbox kernel: vmwgfx 0000:00:02.0: [drm] *ERROR* This configu>
Apr 05 04:59:37 vbox kernel: vmwgfx 0000:00:02.0: [drm] *ERROR* Please switc>
Apr 05 04:59:37 vbox (sd-exec-[340]: /usr/lib/systemd/system-generators/syst>
Apr 05 05:03:09 vbox lightdm[867]: gkr-pam: unable to locate daemon control >
Apr 05 05:03:09 vbox lightdm[757]: pam_systemd(lightdm-greeter:session): Fai>
Apr 05 05:03:14 vbox obexd[1338]: Unable to acquire registery: Error calling>
Apr 05 05:03:14 vbox obexd[1338]: Unable to acquire registery: Error calling>
lines 1-8/8 (END)
```

```
┌──(vbox㉿vbox)-[~]
└─$ sudo journalctl
Feb 26 09:31:23 vbox kernel: Linux version 6.11.2-amd64 (devel@kali.org) (x8>
Feb 26 09:31:23 vbox kernel: Command line: BOOT_IMAGE=/boot/vmlinuz-6.11.2-a>
Feb 26 09:31:23 vbox kernel: [Firmware Bug]: TSC doesn't count with P0 frequ>
Feb 26 09:31:23 vbox kernel: BIOS-provided physical RAM map:
Feb 26 09:31:23 vbox kernel: BIOS-e820: [mem 0x0000000000000000-0x0000000000>
Feb 26 09:31:23 vbox kernel: BIOS-e820: [mem 0x000000000009fc00-0x0000000000>
Feb 26 09:31:23 vbox kernel: BIOS-e820: [mem 0x00000000000f0000-0x0000000000>
Feb 26 09:31:23 vbox kernel: BIOS-e820: [mem 0x0000000000100000-0x00000000df>
Feb 26 09:31:23 vbox kernel: BIOS-e820: [mem 0x00000000dfff0000-0x00000000df>
Feb 26 09:31:23 vbox kernel: BIOS-e820: [mem 0x00000000fec00000-0x00000000fe>
Feb 26 09:31:23 vbox kernel: BIOS-e820: [mem 0x00000000fee00000-0x00000000fe>
Feb 26 09:31:23 vbox kernel: BIOS-e820: [mem 0x00000000fffc0000-0x00000000ff>
Feb 26 09:31:23 vbox kernel: BIOS-e820: [mem 0x0000000100000000-0x0000000120>
Feb 26 09:31:23 vbox kernel: NX (Execute Disable) protection: active
Feb 26 09:31:23 vbox kernel: APIC: Static calls initialized
Feb 26 09:31:23 vbox kernel: SMBIOS 2.5 present.
Feb 26 09:31:23 vbox kernel: DMI: innotek GmbH VirtualBox/VirtualBox, BIOS V>
Feb 26 09:31:23 vbox kernel: DMI: Memory slots populated: 0/0
Feb 26 09:31:23 vbox kernel: Hypervisor detected: KVM
Feb 26 09:31:23 vbox kernel: kvm-clock: Using msrs 4b564d01 and 4b564d00
Feb 26 09:31:23 vbox kernel: kvm-clock: using sched offset of 1943953702139 >
Feb 26 09:31:23 vbox kernel: clocksource: kvm-clock: mask: 0xffffffffffffff>
Feb 26 09:31:23 vbox kernel: tsc: Detected 3792.890 MHz processor
Feb 26 09:31:23 vbox kernel: e820: update [mem 0x00000000-0x00000fff] usable>
Feb 26 09:31:23 vbox kernel: e820: remove [mem 0x000a0000-0x000fffff] usable
Feb 26 09:31:23 vbox kernel: last_pfn = 0x120200 max_arch_pfn = 0x400000000
Feb 26 09:31:23 vbox kernel: MTRR map: 3 entries (3 fixed + 0 variable; max >
Feb 26 09:31:23 vbox kernel: x86/PAT: Configuration [0-7]: WB  WC  UC- UC  W>
Feb 26 09:31:23 vbox kernel: CPU MTRRs all blank - virtualized system.
Feb 26 09:31:23 vbox kernel: last_pfn = 0xe0000 max_arch_pfn = 0x400000000
Feb 26 09:31:23 vbox kernel: found SMP MP-table at [mem 0x0009fbf0-0x0009fbf>
Feb 26 09:31:23 vbox kernel: RAMDISK: [mem 0x29633000-0x30b10fff]
Feb 26 09:31:23 vbox kernel: ACPI: Early table checksum verification disabled
Feb 26 09:31:23 vbox kernel: ACPI: RSDP 0x00000000000E0000 000024 (v02 VBOX >
Feb 26 09:31:23 vbox kernel: ACPI: XSDT 0x00000000DFFF0030 00003C (v01 VBOX >
Feb 26 09:31:23 vbox kernel: ACPI: FACP 0x00000000DFFF00F0 0000F4 (v04 VBOX >
Feb 26 09:31:23 vbox kernel: ACPI: DSDT 0x00000000DFFF0620 002353 (v02 VBOX >
Feb 26 09:31:23 vbox kernel: ACPI: FACS 0x00000000DFFF0200 000040
Feb 26 09:31:23 vbox kernel: ACPI: FACS 0x00000000DFFF0200 000040
Feb 26 09:31:23 vbox kernel: ACPI: APIC 0x00000000DFFF0240 00006C (v02 VBOX >
Feb 26 09:31:23 vbox kernel: ACPI: SSDT 0x00000000DFFF02B0 00036C (v01 VBOX >
Feb 26 09:31:23 vbox kernel: ACPI: Reserving FACP table memory at [mem 0xdff>
Feb 26 09:31:23 vbox kernel: ACPI: Reserving DSDT table memory at [mem 0xdff>
Feb 26 09:31:23 vbox kernel: ACPI: Reserving FACS table memory at [mem 0xdff>
```

SYSTEM PERFORMANCE MONITORING REPORT

Date: April 5, 2025

System: Linux 6.11.2-amd64 (VirtualBox VM)

Analysis Period: 05:04:18 - 05:03:14

EXECUTIVE SUMMARY

This report documents the performance analysis of a Linux system running in a VirtualBox virtualized environment. While the system demonstrates adequate resource availability overall, several critical software errors have been identified that require attention. The detailed technical analysis provided herein offers insights into current system state and recommendations for performance optimization.

SYSTEM SPECIFICATIONS

Component	Details
Operating System	Linux 6.11.2-amd64 (devel@kali.org)
Virtualization	VirtualBox (innotek GmbH)
CPU	3792.800 MHz processor
Memory	3921.4 MB total RAM
Boot Parameters	BOOT_IMAGE=/boot/vmlinuz-6.11.2-amd64
Uptime	00:06:21
Users	2

RESOURCE UTILIZATION METRICS

CPU Performance

Metric	Value	Technical Analysis
Load Average	0.33, 0.24, 0.11	1/5/15-minute averages indicate minimal system load with healthy headroom
Running Processes	1 of 182 (0.5%)	Normal ratio; system not constrained by runnable processes
CPU User Space	0.0%-2.3%	Minimal application CPU consumption
CPU System Space	0.0%-0.7%	Kernel operations consuming minimal resources
Process Priority	Most processes at 20	Standard scheduling priority with some processes at -20 (higher priority)

Process 744 (root) consistently utilizes 2.0-2.3% CPU running /usr/lib/Xorg . The vbox user processes

(PIDs 715, 755, 1066, 1106) utilize between 0.3-0.7% CPU, indicating normal graphics processing overhead for the virtual environment.

Memory Allocation

Metric	Value	Technical Analysis
Total Memory	3921.4 MB	Total physical RAM allocated to VM
Free Memory	2806.4 MB (71.6%)	Substantial free memory available
Used Memory	871.2 MB (22.2%)	Current application memory footprint
Buffers/Cache	464.6 MB (11.8%)	Kernel file caching to improve I/O performance
Total Swap	4095.0 MB	Virtual memory allocation
Used Swap	0.0 MB (0%)	No swap usage indicates adequate physical memory

Memory allocation pattern shows healthy distribution with 663M/3.83G representation in htop output.

The memory-intensive processes include:

- PID 744: 358M VIRT, 117M RES (X server)
- PID 1066: 1192M VIRT, 134M RES (vbox
- process) PID 1106: 776M VIRT, 103M RES (vbox

process)

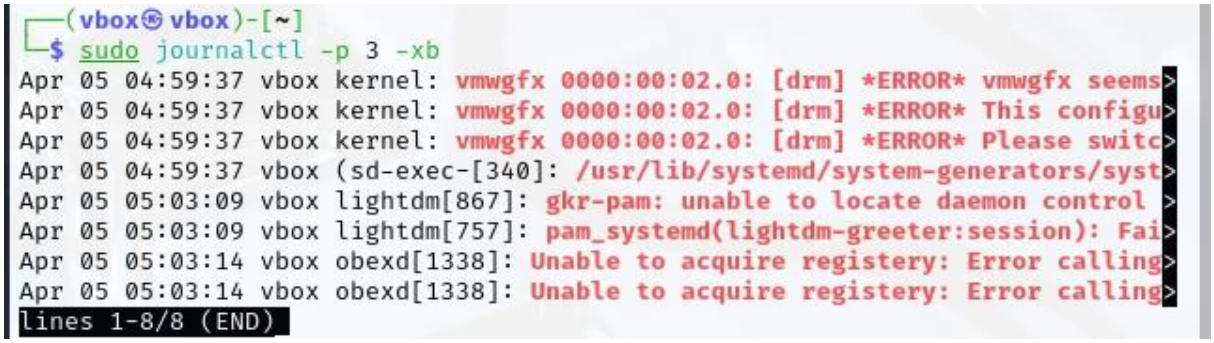
Disk I/O Performance

Metric	Value	Technical Analysis
Total Disk Read	0.00 B/s	No current read operations
Total Disk Write	0.00 B/s	No current write operations
Active Kernel I/O Threads	47	Multiple kernel I/O handlers active but idle
Disk Operation Types	kernel, rcu, migration, kworker	Standard kernel I/O management threads

All disk I/O operations show 0.00 B/s for both read and write, indicating either system idle state or efficient caching. Kernel threads such as `[kworker/0:1-events]` and `[kworker/R-sync-wq]` are present but not actively performing I/O operations.

ERROR ANALYSIS

Critical System Errors



The vmgfx driver errors suggest hardware acceleration incompatibility between the virtual graphics adapter and the Linux driver. The "wedged" status indicates a driver lockup condition that may result in graphics performance degradation.

The system is running with KVM hypervisor detected within the VirtualBox environment, which suggests nested virtualization. This configuration can introduce additional performance overhead and may contribute to the graphics driver issues.

GENERALIZED LAB RUBRICS

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Psychomotor	**Building (**Hardware)	Is able to build a given setup neatly and timely using correct hardware components and / or can reorganize / adapt to new / special requirements	Is able to assemble a given setup using correct hardware components after minor revisions	Is only able to copy a given setup using correct hardware components	Is not able to assemble a given setup using correct hardware components	☐		
Cognitive	**Recording Measurements** (Hardware / Software)	Is able to record accurate measurements all the time	Is able to record accurate measurements most of the time	Is only able to record accurate measurements on some occasions	Is unable to record accurate measurements	☐		
	Investigation (Software)	Is able to formulate /develop theories in addition to evaluating /concluding correctly about investigation parameters by assessing data	Is able to evaluate /conclude correctly about investigation parameters by assessing data	Is partially able to evaluate /conclude correctly about investigation parameters by assessing data	Is unable to comprehend investigation parameters	☐		
	Design / Development of Solution (Hardware / Software)	Is able to design / develop the solution of a given problem and add features to it	Is able to design / develop the solution of a given problem	Is able to partially design / develop the solution of a given problem	Is unable to partially design / develop the solution of a given problem	☐		
	Software Usage (Software)	Is adept in the use of software tool and can access advanced features	Is able to use the software tool effectively by accessing all the required features	Is able to use the software tool but cannot access all the required features	Is unable to use the software tool	☐		
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Domain	Component with Taxonomy	Above Expectation (4)	Meeting Expectation (3)	Approaching Expectation (2)	Below Expectation (1)	Used	Weight / 100 (Optional)	Score (1–4)
Affective	**Safety Instructions (PLO6)**	Assesses and complies with all EHS instructions while in lab	Assesses and complies with most EHS instructions while in lab	Assesses and complies with some EHS instructions while in lab	Assesses and complies with few EHS instructions in lab	☐		
	Professional Ethics (PLO8)	Exhibits exemplary professional ethics while writing lab reports and dealing with fellow students, lab staff and instructor all the time	Exhibits professional ethics while writing lab reports and dealing with fellow students, lab staff and instructor all the time	Makes an effort to exhibit professional ethics while writing lab reports and dealing with fellow students, lab staff and instructor all the time	Does not exhibit professional ethics while writing lab reports and dealing with fellow students, lab staff and instructor all the time	☐		
	Contribution (PLO9)	Consistently shows full preparation by completing all agreed tasks and provides additional resources for the group and work quality is excellent	Consistently shows full preparation by completing all agreed tasks and work requires little or no revisions	Shows some preparation which is mostly at superficial level in completing a task and work requires much revisions and editing	Shows very little or no preparation in completing a task and work quality is poor	☐		
	Attitude (PLO9)	Internalized positive behavior and encourages and helps other team members	Consistent positive behavior most of the time towards other team members	Neither helpful nor damaging and shows disinterest in the performance of others	Discouraging behavior towards other team members	☐		
	Report Writing (PLO10)	Report on all relevant sections related to the lab tasks is completed accurately, meeting the requirements, in prescribed time and with good language skills	Report on all relevant sections related to the lab tasks is completed but few deficiencies are present in terms of accuracy / meeting the requirements / prescribed time / good language skills	Report on all relevant sections related to the lab tasks is completed but many deficiencies are present in terms of accuracy / meeting the requirements / prescribed time / good language skills	Report on all relevant sections related to the lab tasks is not completed	☐		
	Lab Task Management (PLO11)	Manages tasks well within given timeframe	Manages tasks within given timeframe	Manages tasks in an extended timeframe	Does not manage tasks even in extended timeframes	☐		

Lab 15: Final Project

Objective:

Combine all concepts into a real-world project.

Tasks:

- set up a complete LAMP (Linux, Apache, MySQL, PHI') server.

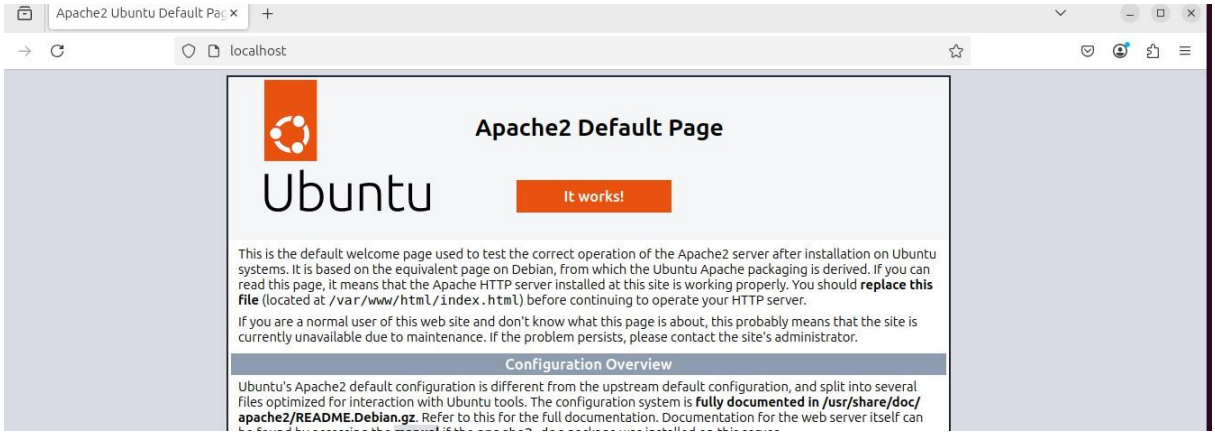
- Implement user permissions, firewall rules, and automation scripts.

- Document the setup and configurations.

Solution:

First I have setup the *apache2* server and run it to checked if it is working correctly:

```
balix@Bali:~$ sudo apt install apache2 -y
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
apache2 is already the newest version (2.4.58-1ubuntu8.6).
0 upgraded, 0 newly installed, 0 to remove and 3 not upgraded.
balix@Bali:~$ sudo systemctl status apache2
● apache2.service - The Apache HTTP Server
     Loaded: loaded (/usr/lib/systemd/system/apache2.service; enabled; preset: >
     Active: active (running) since Thu 2025-04-24 12:00:22 PKT; 22min ago
       Docs: https://httpd.apache.org/docs/2.4/
```



Now I will install the MySQL server in my linux:

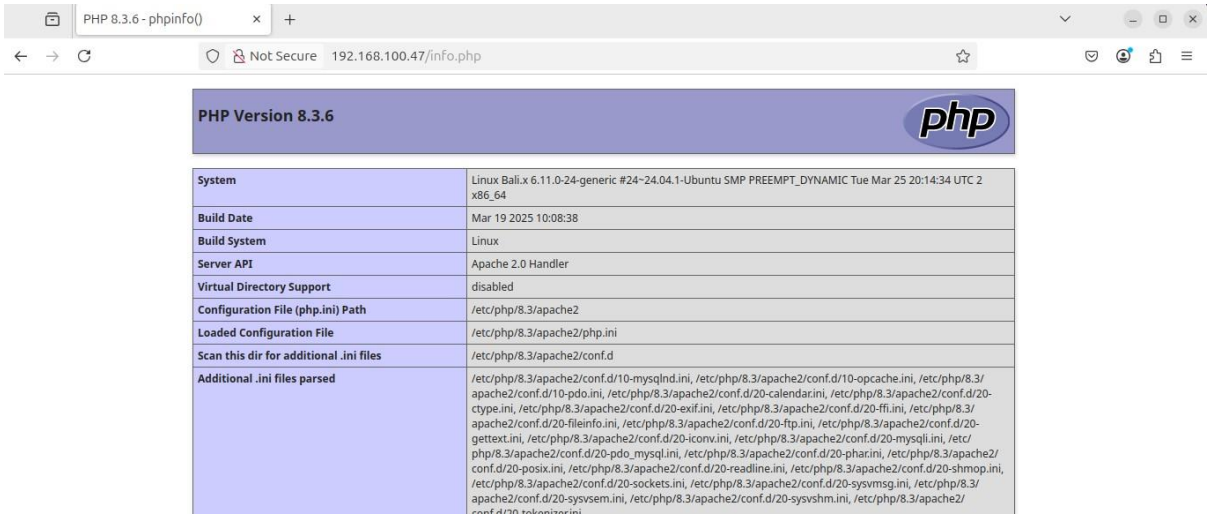
```
balix@Bali:~$ sudo apt install mysql-server -y
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
mysql-server is already the newest version (8.0.41-0ubuntu0.24.04.1).
0 upgraded, 0 newly installed, 0 to remove and 3 not upgraded.
balix@Bali:~$ sudo mysql_secure_installation

Securing the MySQL server deployment.

Connecting to MySQL using a blank password.
The 'validate_password' component is installed on the server.
The subsequent steps will run with the existing configuration
of the component.

Skipping password set for root as authentication with auth_socket is used by default.
If you would like to use password authentication instead, this can be done with the "ALTER_USER" command.
See https://dev.mysql.com/doc/refman/8.0/en/alter-user.html#alter-user-password-management for more information.
```

Now I will install PHP to run it on the server:

```
balix@Bali:~$ sudo apt install php libapache2-mod-php php-mysql -y
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
php is already the newest version (2:8.3+93ubuntu2).
libapache2-mod-php is already the newest version (2:8.3+93ubuntu2).
php-mysql is already the newest version (2:8.3+93ubuntu2).
0 upgraded, 0 newly installed, 0 to remove and 3 not upgraded.
balix@Bali:~$
```

Let me test the php processing :

```
balix@Bali:~$ echo "<?php phpinfo(); ?>" | sudo tee /var/www/html/info.php
```



My php server has been setup successfully

Now I will create a new user in my Linux distro and grant it the permissions to asceses the LAMP stack server admirations

```
balix@Bali:~$ sudo adduser adminweb
info: Adding user `adminweb' ...
info: Selecting UID/GID from range 1000 to 59999 ...
info: Adding new group `adminweb' (1002) ...
info: Adding new user `adminweb' (1002) with group `adminweb (1002)' ...
info: Creating home directory `/home/adminweb' ...
info: Copying files from `/etc/skel' ...
New password:
Retype new password:
passwd: password updated successfully
Changing the user information for adminweb
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] y
info: Adding new user `adminweb' to supplemental / extra groups `users' ...
info: Adding user `adminweb' to group `users' ...
```

```
balix@Bali:~$ sudo usermod -aG sudo adminweb
balix@Bali:~$ sudo chown -R adminweb:www-data /var/www/html/
balix@Bali:~$ sudo chmod -R 755 /var/www/html/
```

Now I will configure some firewall rules for my apache2 server:

```
balix@Bali:~$ sudo ufw allow OpenSSh
Skipping adding existing rule
Skipping adding existing rule (v6)
balix@Bali:~$ sudo ufw allow 'Apache Full'
Skipping adding existing rule
Skipping adding existing rule (v6)
balix@Bali:~$ sudo ufw enable
Firewall is active and enabled on system startup
balix@Bali:~$ sudo ufw status
Status: active

To                         Action      From
--                         ------      ----
22/tcp                     ALLOW       Anywhere
OpenSSH                    ALLOW       Anywhere
Apache Full                ALLOW       Anywhere
22/tcp (v6)                ALLOW       Anywhere (v6)
OpenSSH (v6)               ALLOW       Anywhere (v6)
Apache Full (v6)           ALLOW       Anywhere (v6)

balix@Bali:~$
```

Now for the final step I will make the LAMP setup using a Bash script:

```
balix@Bali:~$ nano lamp_setup.sh
balix@Bali:~$ chmod +x lamp_setup.sh
balix@Bali:~$ ./lamp_setup.sh
Reading package lists... Done
Building dependency tree... Done
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```

```
sudo apt install apache2 -y

sudo apt install mysql-server -y
sudo mysql_secure_installation

sudo apt install php libapache2-mod-php php-mysql -y

sudo systemctl1 restart apache2

sudo chown -R $USER:www-data /var/www/html
sudo chmod -R 755 /var/www/html

echo "LAMP stack installation completed."
```

```
All done!
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
php is already the newest version (2:8.3+93ubuntu2).
libapache2-mod-php is already the newest version (2:8.3+93ubuntu2).
php-mysql is already the newest version (2:8.3+93ubuntu2).
y0 upgraded, 0 newly installed, 0 to remove and 3 not upgraded.
sudo: systemctl1: command not found
LAMP stack installation completed.
```

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