

# Experiment 2: Linux File Systems, Permissions and Commands

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## Experiment 2: Linux File Systems, Permissions, and Essential Commands

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### Aim:

- To understand the structure of Linux file systems.
- To learn and practice essential navigation and file management commands.
- To explore file permissions and ownership, and manage them using Linux commands.
- To use user management, system information commands, and editing tools.
- To solve practical exercises and tasks for mastering Linux basics.

### Requirements

- A Linux machine (Ubuntu/Debian/Linux Mint or similar).
- User privileges to create, modify, and delete files.
- Access to terminal and text editors like `nano` or `vim`.

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## Theory

Linux uses a hierarchical file system starting from the root `/`. Essential directories include `/home`, `/etc`, `/usr`, `/var`, `/bin`, and `/tmp`. File permissions are divided among **owner**, **group**, and **others**, with actions `r` (read), `w` (write), and `x` (execute). Navigation commands like `ls`, `pwd`, `cd`, and file operations (`cp`, `mv`, `rm`) form the basis of Linux usage. Editors (`nano`, `vim`) and commands for system info (`uname`, `df`, `top`, `history`) provide insights and control. Practice tasks build practical confidence.

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## Procedure & Observations

### Section 1: File Systems and Permissions

We learned how Linux organizes directories, how to view and change file permissions using `chmod`, `chown`, and `chgrp`.

### Section 2: Navigation and File Operations

Commands like `ls`, `pwd`, `cd`, `mkdir`, `rmdir`, `touch`, `cp`, `mv`, `rm` were practiced to manage files and directories.

## Section 3: File Viewing and Editing

We used `cat`, `less`, `head`, `tail` to view file contents, and practiced editing with `nano` and `vim`.

## Section 4: User Management

Commands `whoami`, `who`, `passwd`, `sudo` were practiced to understand users and privileges.

## Section 5: System Information

Commands like `uname`, `df`, `top`, `htop`, `history` were used to gather system and process information.

## Section 6: Practice Exercises

Hands-on practice included navigation, file operations, text editing, system exploration, and cleanup.

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## Practice Exercises

### Exercise 1: File System Navigation

```
cd
pwd
mkdir -p projects/linux_practice/{scripts,documents,backup}
cd projects/linux_practice/scripts
touch setup.sh cleanup.sh readme.txt
ls -la
cd ..
ls -la
```

**Output:**

```
retr0@Retr0: $ cd
retr0@Retr0: $ pwd
/home/retr0
retr0@Retr0: $ mkdir -p projects/linux_practice/{scripts,documents,backup}
retr0@Retr0: $ cd projects/linux_practice/scripts/
retr0@Retr0: ~/projects/linux_practice/scripts$ touch setup.sh cleanup.sh readme.txt
retr0@Retr0: ~/projects/linux_practice/scripts$ ls -la
total 8
drwxr-xr-x 2 retr0 retr0 4096 Sep 29 08:40 .
drwxr-xr-x 5 retr0 retr0 4096 Sep 29 08:40 ..
-rw-r--r-- 1 retr0 retr0  0 Sep 29 08:40 cleanup.sh
-rw-r--r-- 1 retr0 retr0  0 Sep 29 08:40 readme.txt
-rw-r--r-- 1 retr0 retr0  0 Sep 29 08:40 setup.sh
retr0@Retr0: ~/projects/linux_practice/scripts$ cd ..
retr0@Retr0: ~/projects/linux_practice$ ls -la
total 20
drwxr-xr-x 5 retr0 retr0 4096 Sep 29 08:40 .
drwxr-xr-x 3 retr0 retr0 4096 Sep 29 08:40 ..
drwxr-xr-x 2 retr0 retr0 4096 Sep 29 08:40 backup
drwxr-xr-x 2 retr0 retr0 4096 Sep 29 08:40 documents
drwxr-xr-x 2 retr0 retr0 4096 Sep 29 08:40 scripts
retr0@Retr0: ~/projects/linux_practice$
```

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## Exercise 2: File Operations and Permissions

```
cd ~/projects/linux_practice/documents
echo "This is a practice document" > practice.txt
ls -l practice.txt
chmod 644 practice.txt
cp practice.txt ../backup/
cp practice.txt ../backup/practice_backup_$(date +%Y%m%d).txt
ls -la ../backup/
```

**Output:**

```
retr0@Retr0: ~/projects/linux_practice$ cd ~/projects/linux_practice/documents
retr0@Retr0: ~/projects/linux_practice/documents$ echo "This is a practice document" > practice.txt
retr0@Retr0: ~/projects/linux_practice/documents$ ls -l practice.txt
-rw-r--r-- 1 retr0 retr0 28 Sep 29 08:42 practice.txt
retr0@Retr0: ~/projects/linux_practice/documents$ chmod 644 practice.txt
retr0@Retr0: ~/projects/linux_practice/documents$ cp practice.txt ../backup/
retr0@Retr0: ~/projects/linux_practice/documents$ cp practice.txt ../backup/practice_backup_$(date +%Y%m%d).txt
retr0@Retr0: ~/projects/linux_practice/documents$ ls -la ../backup/
total 16
drwxr-xr-x 2 retr0 retr0 4096 Sep 29 08:42 .
drwxr-xr-x 5 retr0 retr0 4096 Sep 29 08:40 ..
-rw-r--r-- 1 retr0 retr0 28 Sep 29 08:42 practice.txt
-rw-r--r-- 1 retr0 retr0 28 Sep 29 08:42 practice_backup_20250929.txt
retr0@Retr0: ~/projects/linux_practice/documents$
```

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### Exercise 3: Text Editing and Viewing

```
cd ~/projects/linux_practice/documents
seq 1 50 > numbers.txt
head numbers.txt
tail -n 5 numbers.txt
cat numbers.txt | grep "25"
nano numbers.txt
cat numbers.txt
```

**Output:**

```
Ubuntu-24.04
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
retr0@Retro: ~/projects/linux_practice/documents$

Ubuntu-24.04
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
```

The image consists of two terminal window screenshots. The top screenshot shows the nano 7.2 editor editing a file named 'numbers.txt'. The editor interface includes a title bar 'Ubuntu-24.04' and a status bar with various shortcuts like '^G Help', '^O Write Out', '^W Where Is', '^K Cut', '^T Execute', '^C Location', '^M-U Undo', '^X Exit', '^R Read File', '^\_ Replace', '^U Paste', '^J Justify', '^\_ Go To Line', and '^M-E Redo'. The bottom screenshot shows a terminal session where a file 'numbers.txt' is created using 'seq 1 50 > numbers.txt'. Subsequent commands include 'head numbers.txt', 'tail -n 5 numbers.txt', and 'cat numbers.txt | grep "25"', which outputs the number '25'. The terminal prompt is 'retr0@Retr0:~/projects/linux\_practice/documents\$'.

```
GNU nano 7.2 numbers.txt
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
[ Read 50 lines ]
^G Help      ^O Write Out  ^W Where Is   ^K Cut        ^T Execute    ^C Location   ^M-U Undo
^X Exit      ^R Read File  ^_ Replace    ^U Paste      ^J Justify    ^_ Go To Line ^M-E Redo

retr0@Retr0:~/projects/linux_practice/documents$ cd ~/projects/linux_practice/documents
retr0@Retr0:~/projects/linux_practice/documents$ seq 1 50 > numbers.txt
retr0@Retr0:~/projects/linux_practice/documents$ head numbers.txt
1
2
3
4
5
6
7
8
9
10
retr0@Retr0:~/projects/linux_practice/documents$ tail -n 5 numbers.txt
46
47
48
49
50
retr0@Retr0:~/projects/linux_practice/documents$ cat numbers.txt | grep "25"
25
retr0@Retr0:~/projects/linux_practice/documents$ nano numbers.txt
retr0@Retr0:~/projects/linux_practice/documents$ cat numbers.txt
1
2
3
4
5
6
7
```

## Exercise 4: System Exploration

```
uname -a
df -h
history 10
who
whoami
top
```

Output:

```
retr0@Retr0: $ uname -a
Linux Retr0 6.6.87.2-microsoft-standard-WSL2 #1 SMP PREEMPT_DYNAMIC Thu Jun 5 18:30:46 UTC 2025 x86_64 x86_
64 x86_64 GNU/Linux
retr0@Retr0: $ df -h
Filesystem      Size  Used Avail Use% Mounted on
none            7.7G   0 7.7G   0% /usr/lib/modules/6.6.87.2-microsoft-standard-WSL2
none            7.7G 4.0K 7.7G   1% /mnt/wsl
drivers         1.9T 1.5T 364G  81% /usr/lib/wsl/drivers
/dev/sdd        1007G 2.4G 954G   1% /
none            7.7G  80K 7.7G   1% /mnt/wslg
none            7.7G   0 7.7G   0% /usr/lib/wsl/lib
rootfs          7.7G 2.7M 7.7G   1% /init
none            7.7G 540K 7.7G   1% /run
none            7.7G   0 7.7G   0% /run/lock
none            7.7G   0 7.7G   0% /run/shm
none            7.7G  96K 7.7G   1% /mnt/wslg/versions.txt
none            7.7G  96K 7.7G   1% /mnt/wslg/doc
C:\             1.9T 1.5T 364G  81% /mnt/c
D:\             1.9T 1.7T 168G  92% /mnt/d
tmpfs           7.7G  16K 7.7G   1% /run/user/1000
retr0@Retr0: $ history 10
238 tail -n 5 numbers.txt
239 cat numbers.txt | grep "25"
240 nano numbers.txt
241 cat numbers.txt
242 clear
243 cd
244 clear
245 uname -a
246 df -h

retr0@Retr0: $ history 10
247 history 10
retr0@Retr0: $ who
retr0 pts/1 2025-09-29 08:39
retr0@Retr0: $ whoami
retr0
retr0@Retr0: $ top
top - 08:59:25 up 20 min, 1 user, load average: 0.03, 0.03, 0.00
Tasks: 27 total, 1 running, 26 sleeping, 0 stopped, 0 zombie
%Cpu(s): 0.0 us, 0.6 sy, 0.0 ni, 98.9 id, 0.6 wa, 0.0 hi, 0.0 si, 0.0 st
MiB Mem : 15690.2 total, 15114.2 free, 611.2 used, 162.2 buff/cache
MiB Swap: 4096.0 total, 4096.0 free, 0.0 used, 15078.9 avail Mem

  PID USER      PR  NI   VIRT    RES    SHR S  %CPU  %MEM    TIME+  COMMAND
    1 root        20   0   21848   12384   9184 S   0.0   0.1   0:01.19 systemd
    2 root        20   0    3060    1664    1664 S   0.0   0.0   0:00.02 init-systemd(Ub
    7 root        20   0    3060    1792    1792 S   0.0   0.0   0:00.00 init
   46 root        19  -1   66748   16564   15668 S   0.0   0.1   0:00.40 systemd-journal
   93 root        20   0   25136    6016   4864 S   0.0   0.0   0:00.35 systemd-udevd
  113 systemd+    20   0   21456   12416   10240 S   0.0   0.1   0:00.24 systemd-resolve
  123 systemd+    20   0   91024    7680    6784 S   0.0   0.0   0:00.17 systemd-timesyn
  183 root        20   0    4236    2432    2304 S   0.0   0.0   0:00.02 cron
  184 message+    20   0    9536    4736    4352 S   0.0   0.0   0:00.12 dbus-daemon
  197 root        20   0   17968    8192    7296 S   0.0   0.1   0:00.17 systemd-logind
  199 root        20   0 1755840   12544   10624 S   0.0   0.1   0:00.25 wsl-pro-service
  214 root        20   0    3160    1920    1792 S   0.0   0.0   0:00.02 agetty
  219 syslog      20   0  222508    5504    4352 S   0.0   0.0   0:00.14 rsyslogd
  222 root        20   0    3116    1792    1664 S   0.0   0.0   0:00.01 agetty
  234 root        20   0  107028   22528   13184 S   0.0   0.1   0:00.21 unattended-upgr
  330 root        20   0    3064     896     896 S   0.0   0.0   0:00.00 SessionLeader
  331 root        20   0    3080    1024    1024 S   0.0   0.0   0:00.08 Relay(332)
```

## Exercise 5: Cleanup

```
cd ~/projects/linux_practice
rm -i documents/numbers.txt
rmdir backup
rm -r backup
ls -la
history | tail -20
```

Output:

```
retr0@Retr0: ~$ cd ~/projects/linux_practice
retr0@Retr0:~/projects/linux_practice$ rm -i documents/numbers.txt
rm: remove regular file 'documents/numbers.txt'? y
retr0@Retr0:~/projects/linux_practice$ rmdir backup
rmdir: failed to remove 'backup': Directory not empty
retr0@Retr0:~/projects/linux_practice$ rm -r backup
retr0@Retr0:~/projects/linux_practice$ ls -la
total 16
drwxr-xr-x 4 retr0 retr0 4096 Sep 29 11:57 .
drwxr-xr-x 3 retr0 retr0 4096 Sep 29 08:40 ..
drwxr-xr-x 2 retr0 retr0 4096 Sep 29 11:57 documents
drwxr-xr-x 2 retr0 retr0 4096 Sep 29 08:40 scripts
retr0@Retr0:~/projects/linux_practice$ history | tail -20
199 crontab -e
200 crontab
201 crontab -e
202 ls
203 mkdir parikshit
204 cd parikshit/
205 nano hello.sh
206 chmod +x hello.sh
207 ./hello.sh
208 nano greet.sh
209 chmod +x greet.sh
210 ./greet.sh
211 sudo apt update
212 sudo apt install pandoc
213 cd ~/projects/linux_practice
214 rm -i documents/numbers.txt
215 rmdir backup
```

## Question Bank / Lab Exam Tasks

### Task 1: Directory Navigation

```
mkdir -p ~/test_project/{docs,scripts,data}
cd ~/test_project/scripts
pwd
```

#### Output:

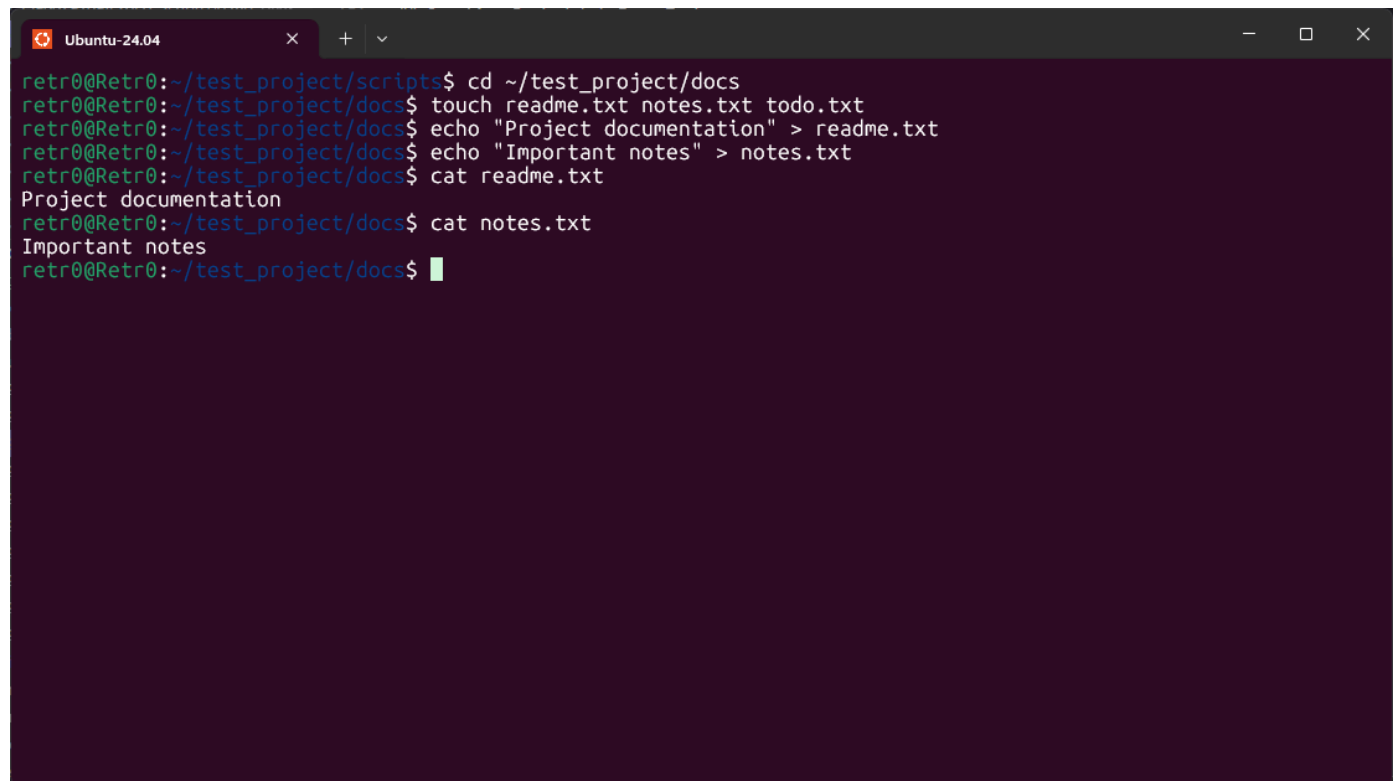
```
retr0@Retr0: ~$ mkdir -p ~/test_project/{docs,scripts,data}
retr0@Retr0: ~$ cd ~/test_project/scripts
retr0@Retr0:~/test_project/scripts$ pwd
/home/retr0/test_project/scripts
retr0@Retr0:~/test_project/scripts$
```



## Task 2: File Creation and Content

```
cd ~/test_project/docs
touch readme.txt notes.txt todo.txt
echo "Project documentation" > readme.txt
echo "Important notes" > notes.txt
cat readme.txt
cat notes.txt
```

### Output:

A terminal window titled 'Ubuntu-24.04' with standard window controls. The terminal shows the following commands and their outputs:

```
retr0@Retr0:~/test_project/scripts$ cd ~/test_project/docs
retr0@Retr0:~/test_project/docs$ touch readme.txt notes.txt todo.txt
retr0@Retr0:~/test_project/docs$ echo "Project documentation" > readme.txt
retr0@Retr0:~/test_project/docs$ echo "Important notes" > notes.txt
retr0@Retr0:~/test_project/docs$ cat readme.txt
Project documentation
retr0@Retr0:~/test_project/docs$ cat notes.txt
Important notes
retr0@Retr0:~/test_project/docs$
```

---

## Task 3: File Operations

```
cp readme.txt ../data/project_info.txt
mv todo.txt ../scripts/
```

### Output:

```
retr0@Retr0: ~/test_project/docs$ cp readme.txt ../data/project_info.txt
retr0@Retr0: ~/test_project/docs$ mv todo.txt ../scripts/
retr0@Retr0: ~/test_project/docs$
```

---

## Task 4: File Permissions

```
cd ~/test_project/scripts
echo "#!/bin/bash" > backup.sh
echo "echo Backup complete" >> backup.sh
chmod u+x backup.sh
ls -l backup.sh
```

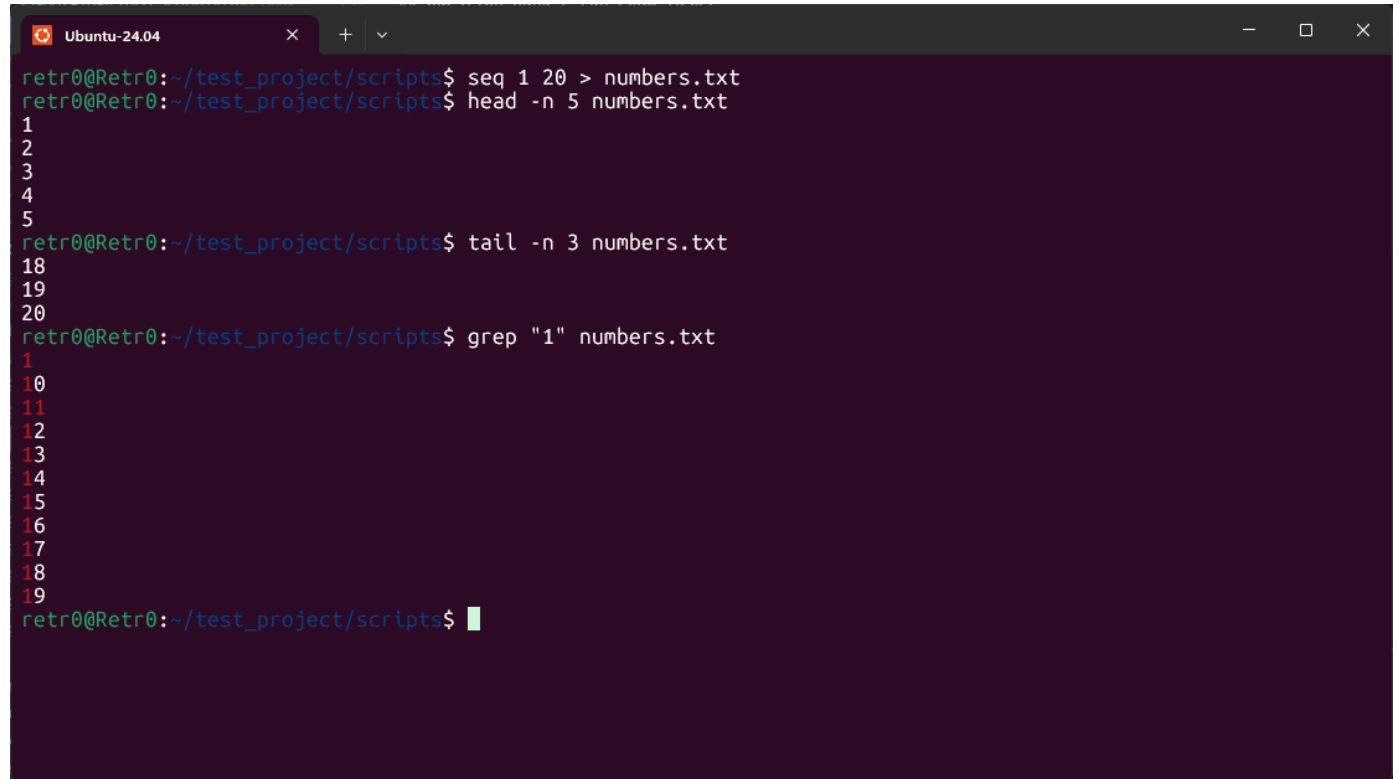
### Output:

```
retr0@Retr0: ~/test_project/docs$ cd ~/test_project/scripts
retr0@Retr0: ~/test_project/scripts$ echo "#!/bin/bash" > backup.sh
-bash: !/bin/bash: event not found
retr0@Retr0: ~/test_project/scripts$ echo "#!/bin/bash" > backup.sh
retr0@Retr0: ~/test_project/scripts$ echo "echo Backup complete" >> backup.sh
retr0@Retr0: ~/test_project/scripts$ chmod u+x backup.sh
retr0@Retr0: ~/test_project/scripts$ ls -l backup.sh
-rwxr--r-- 1 retr0 retr0 34 Sep 29 12:11 backup.sh
retr0@Retr0: ~/test_project/scripts$
```

## Task 5: File Viewing

```
seq 1 20 > numbers.txt  
head -n 5 numbers.txt  
tail -n 3 numbers.txt  
grep "1" numbers.txt
```

### Output:

A terminal window titled 'Ubuntu-24.04' with standard window controls. The terminal shows the following commands and their outputs:  
1. Command: `seq 1 20 > numbers.txt`  
2. Command: `head -n 5 numbers.txt`  
 Output: `1`, `2`, `3`, `4`, `5`  
3. Command: `tail -n 3 numbers.txt`  
 Output: `18`, `19`, `20`  
4. Command: `grep "1" numbers.txt`  
 Output: `1`, `10`, `11`, `12`, `13`, `14`, `15`, `16`, `17`, `18`, `19`  
The prompt `retr0@Retr0:~/test_project/scripts$` is visible at the end of each command line.

---

## Task 6: Text Editing

```
nano config.txt  
cat config.txt
```

### Output:

```
retr0@Retr0:~/test_project/scripts$ nano config.txt
retr0@Retr0:~/test_project/scripts$ cat config.txt
retr0@Retr0:~/test_project/scripts$
```

## Task 7: System Information

```
echo "Username: $(whoami)" > system_info.txt
echo "Date: $(date)" >> system_info.txt
echo "Directory: $(pwd)" >> system_info.txt
df -h >> system_info.txt
cat system_info.txt
```

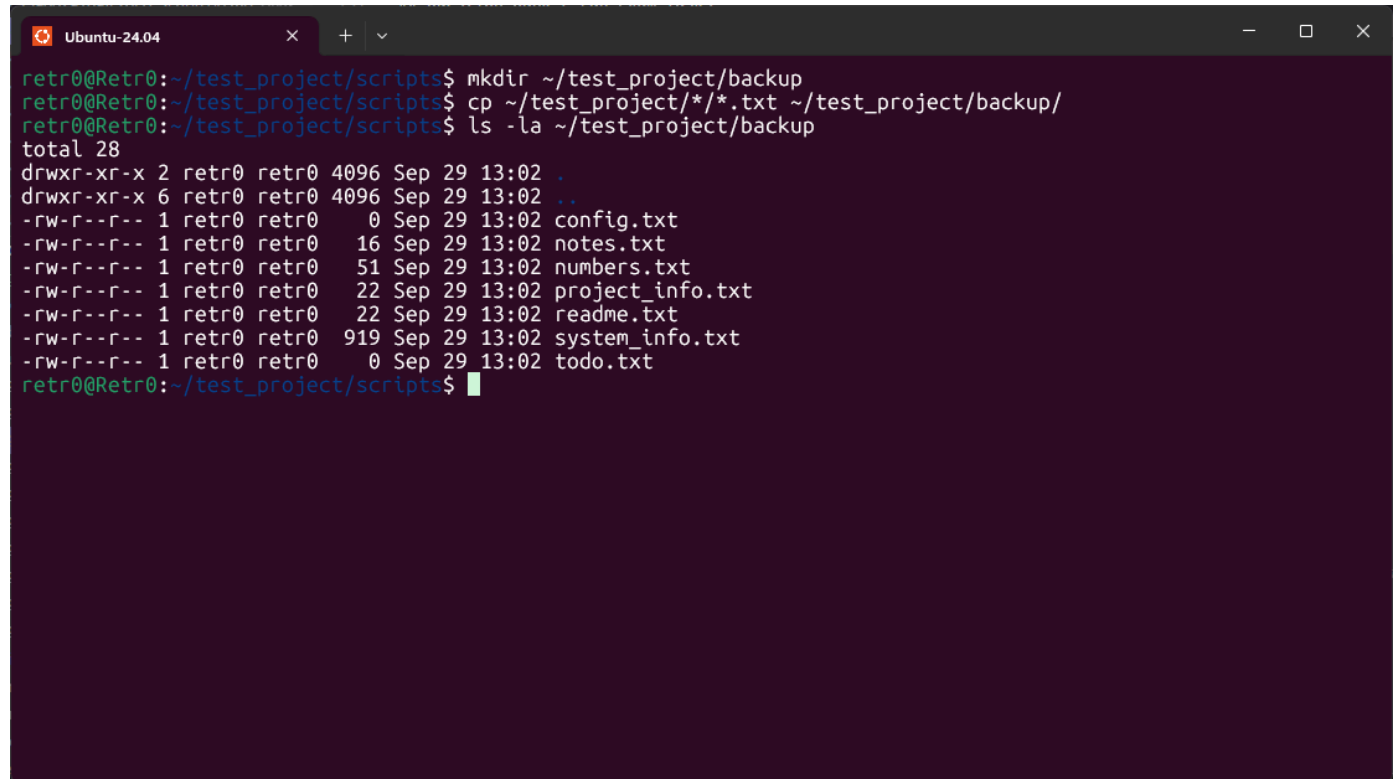
### Output:

```
retr0@Retr0:~/test_project/scripts$ echo "Username: $(whoami)" > system_info.txt
retr0@Retr0:~/test_project/scripts$ echo "Date: $(date)" >> system_info.txt
retr0@Retr0:~/test_project/scripts$ echo "Directory: $(pwd)" >> system_info.txt
retr0@Retr0:~/test_project/scripts$ df -h >> system_info.txt
retr0@Retr0:~/test_project/scripts$ cat system_info.txt
Username: retr0
Date: Mon Sep 29 13:01:32 UTC 2025
Directory: /home/retr0/test_project/scripts
Filesystem      Size  Used Avail Use% Mounted on
none            7.7G   0    7.7G   0% /usr/lib/modules/6.6.87.2-microsoft-standard-WSL2
none            7.7G 4.0K   7.7G   1% /mnt/wsl
drivers         1.9T 1.5T 363G   81% /usr/lib/wsl/drivers
/dev/sdd        1007G 2.4G 954G   1% /
none            7.7G 84K   7.7G   1% /mnt/wslg
none            7.7G   0    7.7G   0% /usr/lib/wsl/lib
rootfs         7.7G 2.7M   7.7G   1% /init
none            7.7G 540K   7.7G   1% /run
none            7.7G   0    7.7G   0% /run/lock
none            7.7G   0    7.7G   0% /run/shm
none            7.7G 96K   7.7G   1% /mnt/wslg/versions.txt
none            7.7G 96K   7.7G   1% /mnt/wslg/doc
C:\             1.9T 1.5T 363G   81% /mnt/c
D:\             1.9T 1.7T 168G   92% /mnt/d
tmpfs           7.7G 16K   7.7G   1% /run/user/1000
retr0@Retr0:~/test_project/scripts$
```

## Task 8: File Organization

```
mkdir ~/test_project/backup
cp ~/test_project/*/*.txt ~/test_project/backup/
ls -la ~/test_project/backup
```

### Output:

A terminal window titled 'Ubuntu-24.04' with standard window controls. The terminal shows the following commands and output:

```
retr0@Retr0:~/test_project/scripts$ mkdir ~/test_project/backup
retr0@Retr0:~/test_project/scripts$ cp ~/test_project/*/*.txt ~/test_project/backup/
retr0@Retr0:~/test_project/scripts$ ls -la ~/test_project/backup
total 28
drwxr-xr-x 2 retr0 retr0 4096 Sep 29 13:02 .
drwxr-xr-x 6 retr0 retr0 4096 Sep 29 13:02 ..
-rw-r--r-- 1 retr0 retr0   0 Sep 29 13:02 config.txt
-rw-r--r-- 1 retr0 retr0  16 Sep 29 13:02 notes.txt
-rw-r--r-- 1 retr0 retr0  51 Sep 29 13:02 numbers.txt
-rw-r--r-- 1 retr0 retr0  22 Sep 29 13:02 project_info.txt
-rw-r--r-- 1 retr0 retr0  22 Sep 29 13:02 readme.txt
-rw-r--r-- 1 retr0 retr0 919 Sep 29 13:02 system_info.txt
-rw-r--r-- 1 retr0 retr0   0 Sep 29 13:02 todo.txt
retr0@Retr0:~/test_project/scripts$
```

---

## Task 9: Process and History

```
history | wc -l
history 10
```

### Output:

```
retr0@Retr0:~/test_project/scripts$ history | wc -l
262
retr0@Retr0:~/test_project/scripts$ history 10
 254 echo "Directory: $(pwd)" >> system_info.txt
 255 df -h >> system_info.txt
 256 cat system_info.txt
 257 clear
 258 mkdir ~/test_project/backup
 259 cp ~/test_project/*.txt ~/test_project/backup/
 260 ls -la ~/test_project/backup
 261 clear
 262 history | wc -l
 263 history 10
retr0@Retr0:~/test_project/scripts$
```

---

## Task 10: Comprehensive Cleanup

```
chmod 754 backup.sh
find ~/test_project -type f | wc -l > summary.txt
find ~/test_project -type d | wc -l >> summary.txt
cat summary.txt
```

### Output:

```
retr0@Retr0:~/test_project/scripts$ chmod 754 backup.sh
retr0@Retr0:~/test_project/scripts$ find ~/test_project -type f | wc -l > summary.txt
retr0@Retr0:~/test_project/scripts$ find ~/test_project -type d | wc -l >> summary.txt
retr0@Retr0:~/test_project/scripts$ cat summary.txt
16
5
retr0@Retr0:~/test_project/scripts$
```

## Result

- Explored Linux file system structure.
- Practiced file operations, editing, and permissions.
- Learned user and system management commands.
- Completed practical exercises and lab exam-style tasks.

## Challenges Faced & Learning Outcomes

- Challenge 1: Managing complex directory structures.
- Challenge 2: Remembering symbolic vs numeric permissions.
- Challenge 3: Using `find`, `grep`, and redirection effectively.

### Learning:

- Mastered Linux navigation, file handling, and permissions.
- Gained practical knowledge of user/system management.
- Practiced exam-style tasks to solidify learning.

## Conclusion

This experiment comprehensively covered **Linux file systems, permissions, commands, editing, user management, and system info**. The tasks ensured thorough practice, making it a complete foundation for Linux proficiency.