

# Operating Systems – COC 3071L

SE 5th A – Fall 2025

## Lab 2: Linux Basics and Introduction

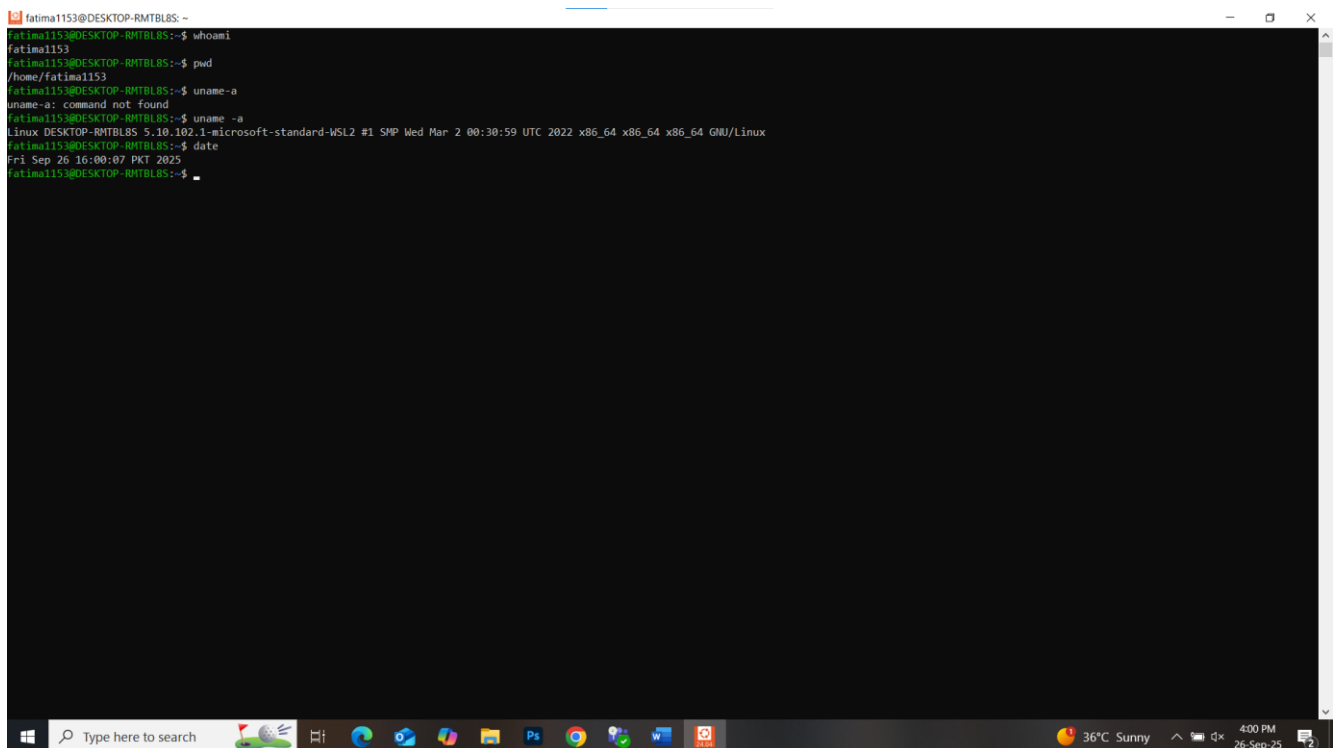
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### Part 1: Linux Environment Orientation

#### 1.1 Understanding the Linux Environment

- ♦ **Concepts to Cover:**
  - What is Linux? Brief history and distributions
  - Linux vs Windows: Key differences
  - Understanding the shell (bash)
  - WSL2 as a Linux environment
- ♦ **Hands-on Activity:**

```
# Students open WSL2 terminal and explore
whoami          # Check current user
pwd             # Print working directory
uname -a        # System information
date            # Current date and time
```



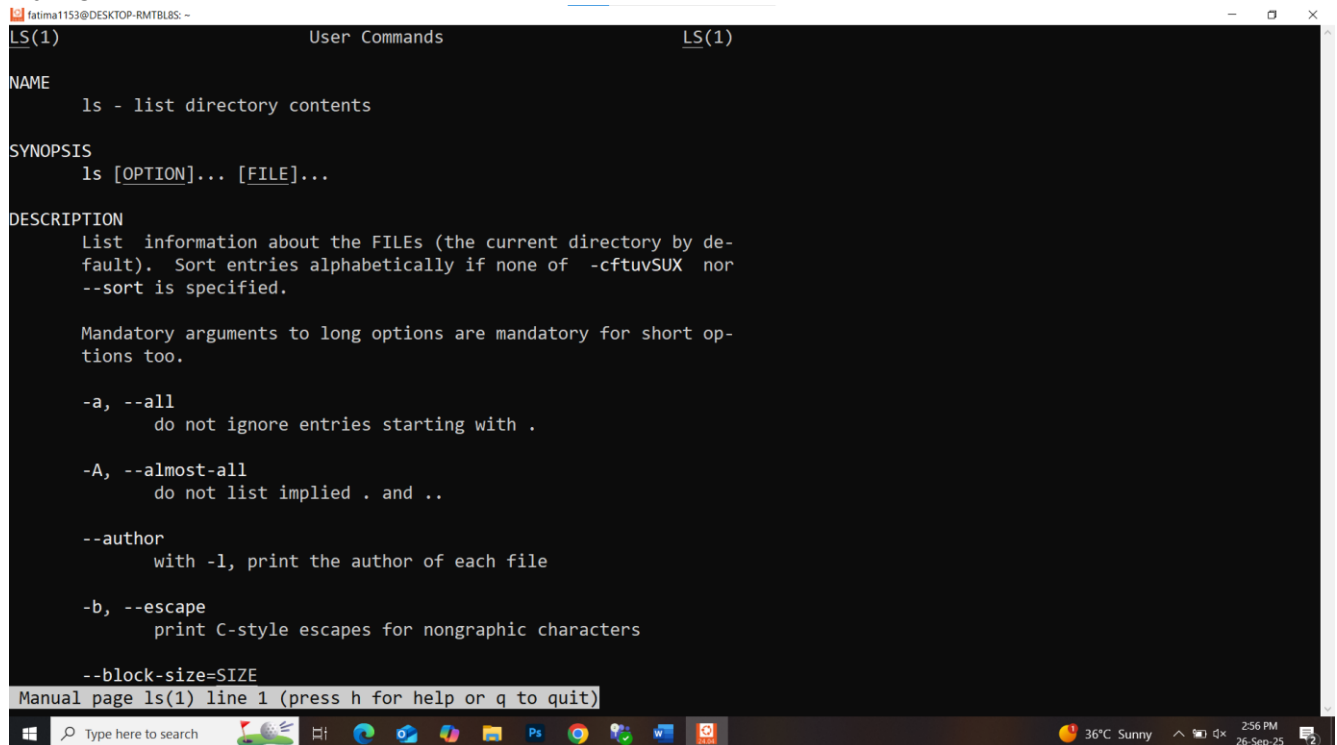
```
fatima1153@DESKTOP-RMTBL8S: ~
fatima1153@DESKTOP-RMTBL8S:~$ whoami
fatima1153
fatima1153@DESKTOP-RMTBL8S:~$ pwd
/home/fatima1153
fatima1153@DESKTOP-RMTBL8S:~$ uname -a
uname -a: command not found
fatima1153@DESKTOP-RMTBL8S:~$ uname -a
Linux DESKTOP-RMTBL8S 5.10.102.1-microsoft-standard-WSL2 #1 SMP Wed Mar 2 00:30:59 UTC 2022 x86_64 x86_64 x86_64 GNU/Linux
fatima1153@DESKTOP-RMTBL8S:~$ date
Fri Sep 26 16:00:07 PKT 2025
fatima1153@DESKTOP-RMTBL8S:~$
```

#### 1.2 Getting Help in Linux

## Commands to demonstrate:

```
man ls      # Manual pages
ls --help   # Built-in help
which ls     # Location of commands
type ls      # Command type information
```

### Man ls:



```
fatima1153@DESKTOP-RMTBL8S: ~
LS(1) User Commands LS(1)
NAME
  ls - list directory contents
SYNOPSIS
  ls [OPTION]... [FILE]...
DESCRIPTION
  List information about the FILES (the current directory by default). Sort entries alphabetically if none of -cftuvSUX nor --sort is specified.

  Mandatory arguments to long options are mandatory for short options too.

  -a, --all
      do not ignore entries starting with .

  -A, --almost-all
      do not list implied . and ..

  --author
      with -l, print the author of each file

  -b, --escape
      print C-style escapes for nongraphic characters

  --block-size=SIZE
Manual page ls(1) line 1 (press h for help or q to quit)
```

### Ls --help:

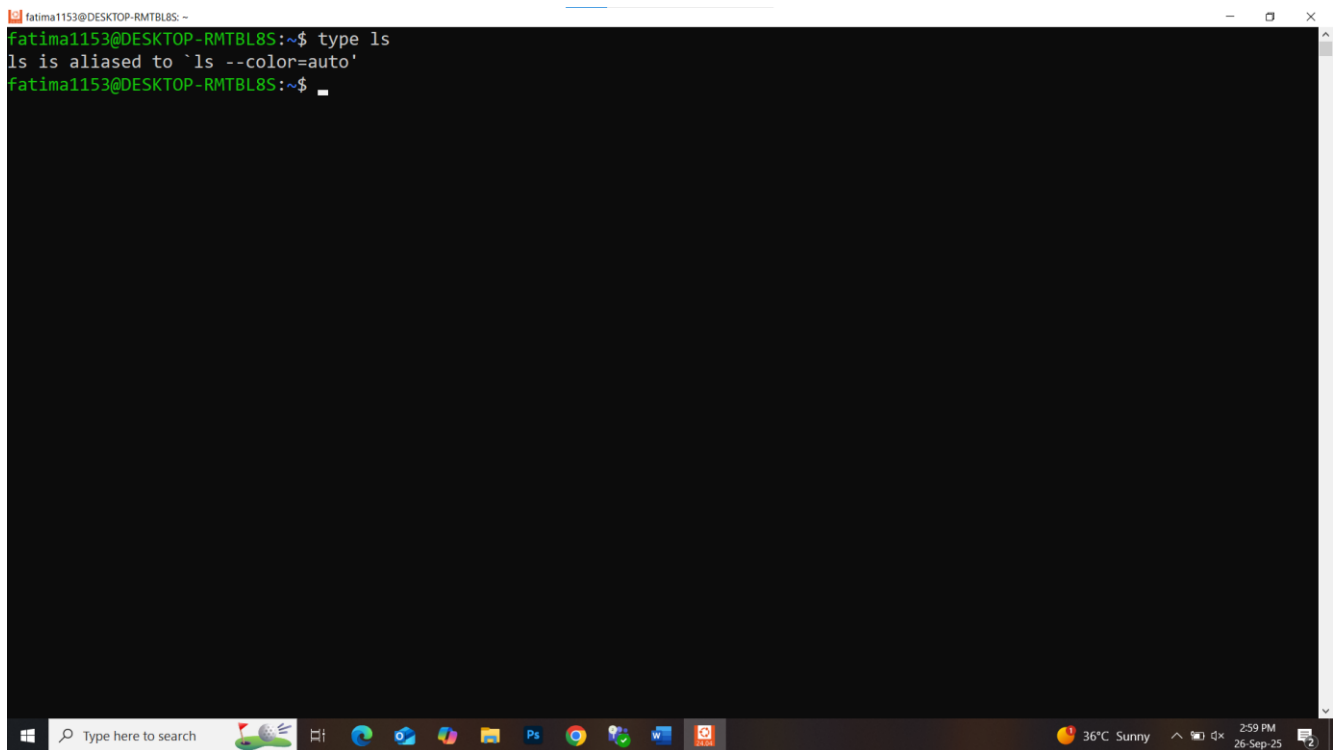
```
fatima1153@DESKTOP-RMTBL8S: ~  
The WHEN argument defaults to 'always' and can also be 'auto' or 'never'.  
  
Using color to distinguish file types is disabled both by default and  
with --color=never. With --color=auto, ls emits color codes only when  
standard output is connected to a terminal. The LS_COLORS environment  
variable can change the settings. Use the dircolors(1) command to set it.  
  
Exit status:  
 0 if OK,  
 1 if minor problems (e.g., cannot access subdirectory),  
 2 if serious trouble (e.g., cannot access command-line argument).  
  
GNU coreutils online help: <https://www.gnu.org/software/coreutils/>  
Report any translation bugs to <https://translationproject.org/team/>  
Full documentation <https://www.gnu.org/software/coreutils/ls>  
or available locally via: info '(coreutils) ls invocation'  
fatima1153@DESKTOP-RMTBL8S:~$
```

## Which ls:

```
fatima1153@DESKTOP-RMTBL8S: ~  
fatima1153@DESKTOP-RMTBL8S:~$ which ls  
/usr/bin/ls  
fatima1153@DESKTOP-RMTBL8S:~$
```

## Type ls:

```
fatima1153@DESKTOP-RMTBL8S: ~  
fatima1153@DESKTOP-RMTBL8S:~$ type ls  
ls is aliased to `ls --color=auto`  
fatima1153@DESKTOP-RMTBL8S:~$
```



## Part 2: File System Navigation

### 2.1 Understanding Linux Directory Structure

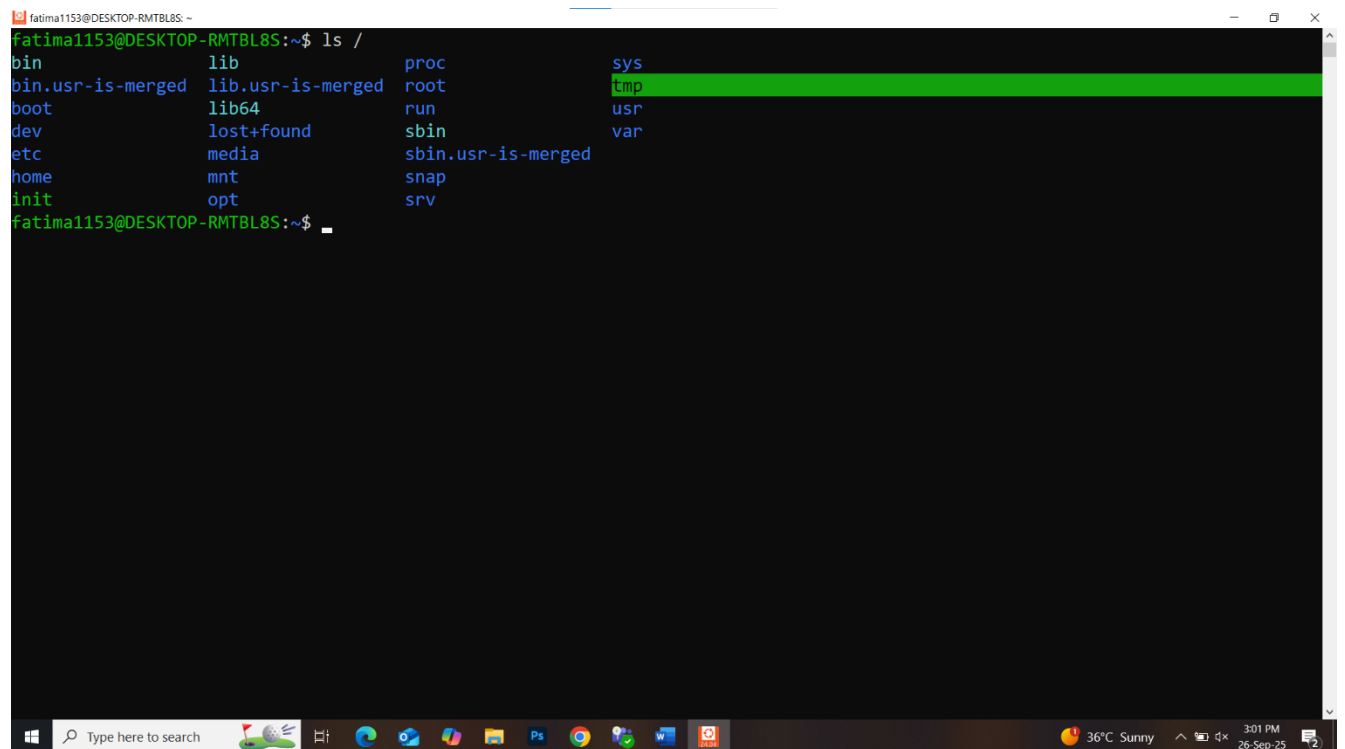
- ◆ **Concepts to Cover:**
  - Root directory (/)
  - Important directories: /home, /usr, /etc, /var, /tmp

- Absolute vs relative paths
- Hidden files and directories

♦ **Demonstration:**

```
ls /           # Root directory contents
ls -la        # Long listing with hidden files
cd /home      # Change directory
cd ~          # Home directory shortcut
cd -          # Previous directory
```

**List root directory:**



A terminal window titled 'fatima1153@DESKTOP-RMTBL8S: ~' showing the command 'ls /' and its output. The output lists the root directory contents in four columns: bin, bin.usr-is-merged, boot, dev, etc, home, init, fatima1153@DESKTOP-RMTBL8S:~\$; lib, lib.usr-is-merged, lib64, lost+found, media, mnt, opt; proc, root, run, sbin, sbin.usr-is-merged, snap, srv; sys, tmp, usr, var. The 'tmp' directory is highlighted in green. The terminal window is overlaid on a Windows desktop with a taskbar at the bottom showing various application icons and system information: 36°C, Sunny, 3:01 PM, 26-Sep-25.

```
fatima1153@DESKTOP-RMTBL8S:~$ ls /
bin          lib          proc         sys
bin.usr-is-merged lib.usr-is-merged root         tmp
boot        lib64        run          usr
dev         lost+found  sbin        var
etc         media       sbin.usr-is-merged
home        mnt         snap
init        opt         srv
fatima1153@DESKTOP-RMTBL8S:~$
```

**List all files:**

```
fatima1153@DESKTOP-RMTBL8S: ~  
drwxr-xr-x  2 root root    4096 Apr  8  2024 lib.usr-is-merged  
lrwxrwxrwx  1 root root      9 Apr 22  2024 lib64 -> usr/lib64  
drwx----- 2 root root 16384 Apr 10  2019 lost+found  
drwxr-xr-x  2 root root    4096 Jan  7  2025 media  
drwxr-xr-x  8 root root    4096 Sep 19 15:57 mnt  
drwxr-xr-x  2 root root    4096 Jan  7  2025 opt  
dr-xr-xr-x 140 root root      0 Sep 26 14:07 proc  
drwx----- 3 root root    4096 Jan  7  2025 root  
drwxr-xr-x  8 root root    160 Sep 26 14:07 run  
lrwxrwxrwx  1 root root      8 Apr 22  2024 sbin -> usr/sbin  
drwxr-xr-x  2 root root    4096 Mar 31  2024 sbin.usr-is-merged  
drwxr-xr-x  2 root root    4096 Oct 11  2024 snap  
drwxr-xr-x  2 root root    4096 Jan  7  2025 srv  
dr-xr-xr-x 11 root root      0 Sep 26 14:07 sys  
drwxrwxrwt  2 root root    4096 Sep 25 20:42 tmp  
drwxr-xr-x 12 root root    4096 Jan  7  2025 usr  
drwxr-xr-x 13 root root    4096 Jan  7  2025 var  
fatima1153@DESKTOP-RMTBL8S:~$
```

**Change directory to /home:**

```
fatima1153@DESKTOP-RMTBL8S: /home  
fatima1153@DESKTOP-RMTBL8S:/home$ cd /home  
fatima1153@DESKTOP-RMTBL8S:/home$
```

**Change to home directory shortcut:**

```
fatima1153@DESKTOP-RMTBL8S: ~  
fatima1153@DESKTOP-RMTBL8S:/home$ cd /home  
fatima1153@DESKTOP-RMTBL8S:/home$ cd ~  
fatima1153@DESKTOP-RMTBL8S:~$
```

Go to previous directory:

```
fatima1153@DESKTOP-RMTBL8S: /home  
fatima1153@DESKTOP-RMTBL8S:/home$ cd /home  
fatima1153@DESKTOP-RMTBL8S:/home$ cd ~  
fatima1153@DESKTOP-RMTBL8S:~$ cd -  
/home  
fatima1153@DESKTOP-RMTBL8S:/home$
```

## 2.2 Basic Navigation Commands (15 minutes)

## Commands to practice:

<code>pwd</code>	# Present working directory
<code>ls</code>	# List directory contents
<code>ls -l</code>	# Long format
<code>ls -la</code>	# Include hidden files
<code>ls -lh</code>	# Human readable sizes
<code>cd</code>	# Change directory
<code>cd ..</code>	# Parent directory
<code>cd ~</code>	# Home directory
<code>cd /</code>	# Root directory

```
fatima1153@DESKTOP-RMTBL8S: /
fatima1153@DESKTOP-RMTBL8S:~$ pwd
/home/fatima1153
fatima1153@DESKTOP-RMTBL8S:~$ ls
file.txt  folder  hello.c  hello.txt  wsl_lab1
fatima1153@DESKTOP-RMTBL8S:~$ ls -l
total 32
-rw-r--r-- 1 fatima1153 fatima1153  0 Sep 26 14:30 file.txt
drwxr-xr-x 3 fatima1153 fatima1153 4096 Sep 26 14:34 folder
-rw-r--r-- 1 fatima1153 fatima1153 15960 Sep 25 20:42 hello
-rw-r--r-- 1 fatima1153 fatima1153  79 Sep 25 20:41 hello.c
-rw-r--r-- 1 fatima1153 fatima1153   6 Sep 26 14:32 hello.txt
drwxr-xr-x 3 fatima1153 fatima1153 4096 Sep 20 14:41 wsl_lab1
fatima1153@DESKTOP-RMTBL8S:~$ ls -lh
total 32K
-rw-r--r-- 1 fatima1153 fatima1153  0 Sep 26 14:30 file.txt
drwxr-xr-x 3 fatima1153 fatima1153 4.0K Sep 26 14:34 folder
-rw-r--r-- 1 fatima1153 fatima1153 16K Sep 25 20:42 hello
-rw-r--r-- 1 fatima1153 fatima1153 79 Sep 25 20:41 hello.c
-rw-r--r-- 1 fatima1153 fatima1153  6 Sep 26 14:32 hello.txt
drwxr-xr-x 3 fatima1153 fatima1153 4.0K Sep 20 14:41 wsl_lab1
fatima1153@DESKTOP-RMTBL8S:~$ cd
fatima1153@DESKTOP-RMTBL8S:~$ cd..
cd..: command not found
fatima1153@DESKTOP-RMTBL8S:~$ cd ..
fatima1153@DESKTOP-RMTBL8S:/home$ cd ~
fatima1153@DESKTOP-RMTBL8S:~$ cd /
fatima1153@DESKTOP-RMTBL8S:/$_
```

## Part 3: File and Directory Operations

### \*\*3.1 Creating and Managing Files/Directories

- ◆ Commands to demonstrate:



```

mkdir mylab2           # Create directory
mkdir -p test/sub/dir  # Create nested directories
touch file1.txt        # Create empty file
touch file2.txt file3.txt  # Multiple files

# Text editors introduction
nano hello.txt          # Simple text editor
# OR
echo "Hello Linux!" > hello.txt  # Redirect output to file

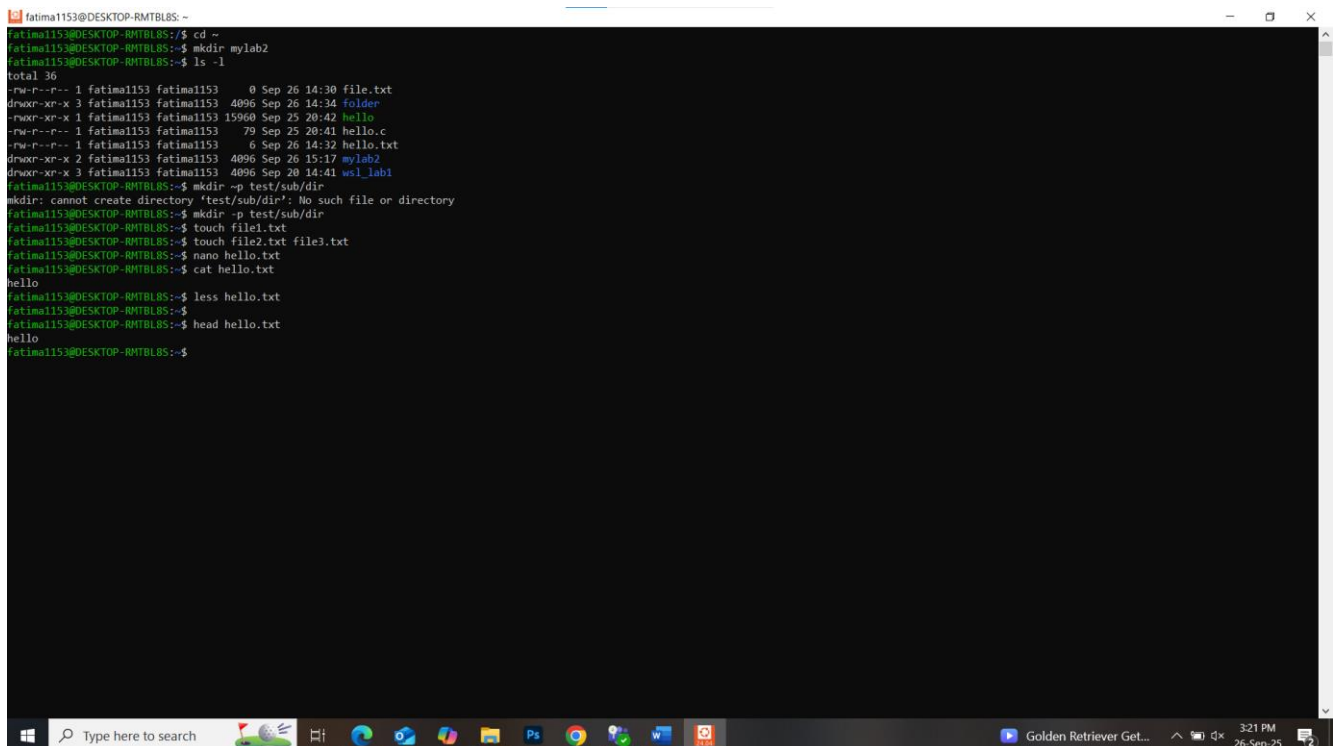
```

#### ♦ File viewing commands

```

cat hello.txt           # Display file contents
less hello.txt          # Page through file
head hello.txt          # First 10 lines

```



```

fatima1153@DESKTOP-RMTBL8S: ~
fatima1153@DESKTOP-RMTBL8S:~$ cd ~
fatima1153@DESKTOP-RMTBL8S:~$ mkdir mylab2
fatima1153@DESKTOP-RMTBL8S:~$ ls -l
total 36
-rw-r--r-- 1 fatima1153 fatima1153 0 Sep 26 14:30 file.txt
drwxr-xr-x 3 fatima1153 fatima1153 4096 Sep 26 14:34 folder
-rwxr-xr-x 1 fatima1153 fatima1153 15960 Sep 25 20:42 hello
-rw-r--r-- 1 fatima1153 fatima1153 79 Sep 25 20:41 hello.c
-rw-r--r-- 1 fatima1153 fatima1153 6 Sep 26 14:32 hello.txt
drwxr-xr-x 2 fatima1153 fatima1153 4096 Sep 26 15:17 mylab2
drwxr-xr-x 3 fatima1153 fatima1153 4096 Sep 20 14:41 wsl_lab1
fatima1153@DESKTOP-RMTBL8S:~$ mkdir -p test/sub/dir
mkdir: cannot create directory 'test/sub/dir': No such file or directory
fatima1153@DESKTOP-RMTBL8S:~$ mkdir -p test/sub/dir
fatima1153@DESKTOP-RMTBL8S:~$ touch file1.txt
fatima1153@DESKTOP-RMTBL8S:~$ touch file2.txt file3.txt
fatima1153@DESKTOP-RMTBL8S:~$ nano hello.txt
fatima1153@DESKTOP-RMTBL8S:~$ cat hello.txt
hello
fatima1153@DESKTOP-RMTBL8S:~$ less hello.txt
fatima1153@DESKTOP-RMTBL8S:~$
fatima1153@DESKTOP-RMTBL8S:~$ head hello.txt
hello
fatima1153@DESKTOP-RMTBL8S:~$

```

```
tail hello.txt      # Last 10 lines
wc hello.txt        # Word count
```

```
fatima1153@DESKTOP-RMTBLS: ~
fatima1153@DESKTOP-RMTBLS:~$ cd ~
fatima1153@DESKTOP-RMTBLS:~$ mkdir mylab2
fatima1153@DESKTOP-RMTBLS:~$ ls -l
total 36
-rw-r--r-- 1 fatima1153 fatima1153  0 Sep 26 14:30 file.txt
drwxr-xr-x 3 fatima1153 fatima1153 4096 Sep 26 14:34 folder
-rwxr-xr-x 1 fatima1153 fatima1153 15960 Sep 25 20:42 hello
-rw-r--r-- 1 fatima1153 fatima1153   79 Sep 25 20:41 hello.c
-rw-r--r-- 1 fatima1153 fatima1153   6 Sep 26 14:32 hello.txt
drwxr-xr-x 2 fatima1153 fatima1153 4096 Sep 26 15:17 mylab2
drwxr-xr-x 3 fatima1153 fatima1153 4096 Sep 20 14:41 wsl_lab1
fatima1153@DESKTOP-RMTBLS:~$ mkdir -p test/sub/dir
mkdir: cannot create directory 'test/sub/dir': No such file or directory
fatima1153@DESKTOP-RMTBLS:~$ mkdir -p test/sub/dir
fatima1153@DESKTOP-RMTBLS:~$ touch file1.txt
fatima1153@DESKTOP-RMTBLS:~$ touch file2.txt file3.txt
fatima1153@DESKTOP-RMTBLS:~$ nano hello.txt
fatima1153@DESKTOP-RMTBLS:~$ cat hello.txt
hello
fatima1153@DESKTOP-RMTBLS:~$ less hello.txt
fatima1153@DESKTOP-RMTBLS:~$
fatima1153@DESKTOP-RMTBLS:~$ head hello.txt
hello
fatima1153@DESKTOP-RMTBLS:~$ tail hello.txt
hello
fatima1153@DESKTOP-RMTBLS:~$ wc hello.txt
 1 1 6 hello.txt
fatima1153@DESKTOP-RMTBLS:~$
```

## 3.2 Copying, Moving, and Deleting

- ◆ **Commands to practice:**

```
cp hello.txt backup.txt      # Copy file
cp -r mylab2 mylab2_backup   # Copy directory recursively
mv backup.txt renamed.txt    # Move/rename file
rm renamed.txt               # Remove file
rm -r mylab2_backup          # Remove directory
rmdir empty_directory        # Remove empty directory
```

**Hands-on Exercise:** Students create a directory structure, add files, and practice file operations.

```
fatima1153@DESKTOP-RMTBLS: ~  
fatima1153@DESKTOP-RMTBLS:~$ mkdir backup_folder  
fatima1153@DESKTOP-RMTBLS:~$ cp file1.txt file2.txt backup_folder/  
fatima1153@DESKTOP-RMTBLS:~$ ls backup_folder  
file1.txt  file2.txt  
fatima1153@DESKTOP-RMTBLS:~$ mv hello.txt backup_folder/  
fatima1153@DESKTOP-RMTBLS:~$ ls backup_folder  
file1.txt  file2.txt  hello.txt  
fatima1153@DESKTOP-RMTBLS:~$ mv backup_folder/hello.txt backup_folder/greeting.txt  
fatima1153@DESKTOP-RMTBLS:~$ ls backup_folder  
file1.txt  file2.txt  greeting.txt  
fatima1153@DESKTOP-RMTBLS:~$ rm backup_folder/file1.txt  
fatima1153@DESKTOP-RMTBLS:~$ ls backup_folder  
file2.txt  greeting.txt  
fatima1153@DESKTOP-RMTBLS:~$ rm backup_folder/file2.txt backup_folder/greeting.txt  
fatima1153@DESKTOP-RMTBLS:~$ ls backup_folder  
fatima1153@DESKTOP-RMTBLS:~$
```

## Part 4: File Permissions and Ownership

### 4.1 Understanding File Permissions

- ◆ **Concepts to Cover:**

- Permission types: read (r), write (w), execute (x)
- Permission groups: user (u), group (g), others (o)
- Numeric notation: 755, 644, etc.

- ◆ **Commands to demonstrate:**

```
ls -l          # View permissions  
chmod 755 file.txt # Change permissions (numeric)  
chmod u+x file.txt # Add execute permission for user  
chmod g-w file.txt # Remove write permission for group  
chown user:group file.txt # Change ownership (if applicable)
```

```
fatima1153@DESKTOP-RMTBLS: ~  
fatima1153@DESKTOP-RMTBLS:~$ ls -l  
total 52  
-rw-r--r-- 1 fatima1153 fatima1153 6 Sep 26 15:26 backup.txt  
drwxr-xr-x 2 fatima1153 fatima1153 4096 Sep 26 15:31 backup_folder  
-rw-r--r-- 1 fatima1153 fatima1153 0 Sep 26 14:30 file.txt  
-rw-r--r-- 1 fatima1153 fatima1153 0 Sep 26 15:18 file1.txt  
-rw-r--r-- 1 fatima1153 fatima1153 0 Sep 26 15:19 file2.txt  
-rw-r--r-- 1 fatima1153 fatima1153 0 Sep 26 15:19 file3.txt  
drwxr-xr-x 3 fatima1153 fatima1153 4096 Sep 26 14:34 folder  
-rwxr-xr-x 1 fatima1153 fatima1153 15968 Sep 25 20:42 hello  
-rw-r--r-- 1 fatima1153 fatima1153 79 Sep 25 20:41 hello.c  
drwxr-xr-x 2 fatima1153 fatima1153 4096 Sep 26 15:17 mylab2  
-rw-r--r-- 1 fatima1153 fatima1153 6 Sep 26 15:23 renamed.txt  
drwxr-xr-x 3 fatima1153 fatima1153 4096 Sep 26 15:18 test  
drwxr-xr-x 3 fatima1153 fatima1153 4096 Sep 20 14:41 wsl_lab1  
drwxr-xr-x 2 fatima1153 fatima1153 4096 Sep 26 15:18 '~p'  
fatima1153@DESKTOP-RMTBLS:~$ chmod 755 file.txt  
fatima1153@DESKTOP-RMTBLS:~$ chmod u+x file.txt  
fatima1153@DESKTOP-RMTBLS:~$ chmod g-w file.txt  
fatima1153@DESKTOP-RMTBLS:~$ chown user:group file.txt  
chown: invalid user: 'user:group'  
fatima1153@DESKTOP-RMTBLS:~$ sudo chown fatima1153:fatima1153 file.txt  
[sudo] password for fatima1153:  
fatima1153@DESKTOP-RMTBLS:~$ ls -l file.txt  
-rwxr-xr-x 1 fatima1153 fatima1153 0 Sep 26 14:30 file.txt  
fatima1153@DESKTOP-RMTBLS:~$
```

## Part 5: Text Processing and Utilities

### 5.1 Essential Text Commands

- ◆ Commands to demonstrate:

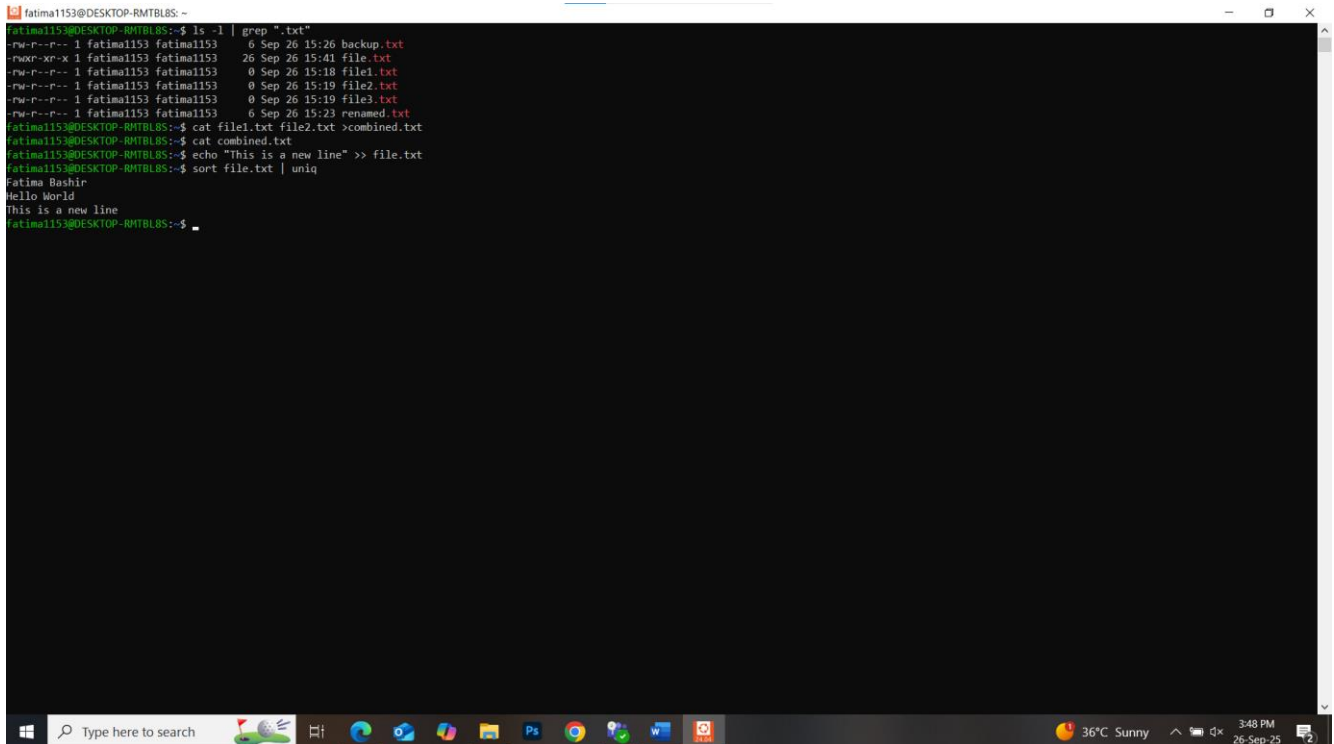
```
grep "pattern" file.txt      # Search for patterns  
grep -i "pattern" file.txt   # Case-insensitive search  
grep -n "pattern" file.txt   # Show line numbers
```

```
fatima1153@DESKTOP-RMTBLS: ~  
fatima1153@DESKTOP-RMTBLS:~$ grep "pattern" file.txt  
fatima1153@DESKTOP-RMTBLS:~$ echo "Hello World" > file.txt  
fatima1153@DESKTOP-RMTBLS:~$ echo "Fatima Bashir" >> file.txt  
fatima1153@DESKTOP-RMTBLS:~$ cat file.txt  
Hello World  
Fatima Bashir  
fatima1153@DESKTOP-RMTBLS:~$ grep "Fatima" file.txt  
Fatima Bashir  
fatima1153@DESKTOP-RMTBLS:~$ grep -i "fatima" file.txt  
Fatima Bashir  
fatima1153@DESKTOP-RMTBLS:~$ grep -n "Fatima" file.txt  
2:Fatima Bashir  
fatima1153@DESKTOP-RMTBLS:~$
```

## 5.2 Pipes and Redirection

- ◆ Concepts and commands:

```
ls -l | grep ".txt"          # Pipe output
cat file1.txt file2.txt > combined.txt # Redirect output
echo "new line" >> file.txt # Append to file
sort file.txt | uniq         # Chain commands
```



```
fatima1153@DESKTOP-RMTBLS: ~
fatima1153@DESKTOP-RMTBLS:~$ ls -l | grep ".txt"
-rw-r--r-- 1 fatima1153 fatima1153 6 Sep 26 15:26 backup.txt
-rwxr-xr-x 1 fatima1153 fatima1153 26 Sep 26 15:41 file.txt
-rw-r--r-- 1 fatima1153 fatima1153 0 Sep 26 15:18 file1.txt
-rw-r--r-- 1 fatima1153 fatima1153 0 Sep 26 15:19 file2.txt
-rw-r--r-- 1 fatima1153 fatima1153 0 Sep 26 15:19 file3.txt
-rw-r--r-- 1 fatima1153 fatima1153 6 Sep 26 15:23 renamed.txt
fatima1153@DESKTOP-RMTBLS:~$ cat file1.txt file2.txt > combined.txt
fatima1153@DESKTOP-RMTBLS:~$ cat combined.txt
fatima1153@DESKTOP-RMTBLS:~$ echo "This is a new line" >> file.txt
fatima1153@DESKTOP-RMTBLS:~$ sort file.txt | uniq
Fatima Bashir
Hello World
This is a new line
fatima1153@DESKTOP-RMTBLS:~$
```

## Part 6: Introduction to Processes

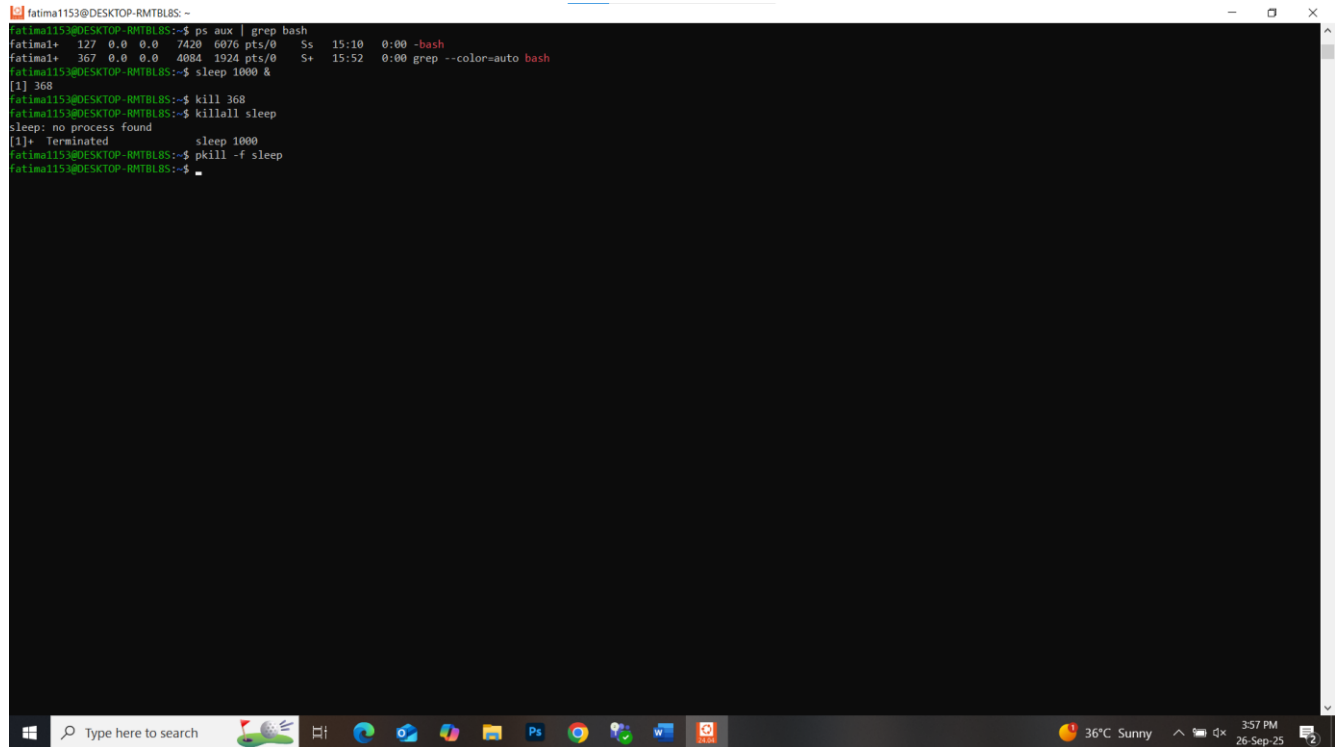
### 6.1 Understanding Processes

- ◆ Concepts to Cover:

- What is a process?
- Process ID (PID)
- Parent-child relationships
- Process states

- ◆ **Commands to demonstrate:**

<b>ps</b>	# Show current processes
<b>ps aux</b>	# Detailed process list
<b>ps -ef</b>	# Full format listing
<b>pstree</b>	# Process tree
<b>top</b>	# Real-time process viewer
<b>htop</b>	# Enhanced process viewer (if available)
<b>kill</b> PID	# Terminate process by PID
<b>killall</b> process_name	# Kill processes by name
<b>pkill</b> pattern	# Kill processes matching pattern



```
fatima1153@DESKTOP-RMTBLBS: ~  
fatima1153@DESKTOP-RMTBLBS:~$ ps aux | grep bash  
fatima1+ 127 0.0 0.0 7420 6076 pts/0 Ss 15:10 0:00 -bash  
fatima1+ 367 0.0 0.0 4084 1924 pts/0 S+ 15:52 0:00 grep --color=auto bash  
fatima1153@DESKTOP-RMTBLBS:~$ sleep 1000 &  
[1] 368  
fatima1153@DESKTOP-RMTBLBS:~$ kill 368  
fatima1153@DESKTOP-RMTBLBS:~$ killall sleep  
sleep: no process found  
[1]+ Terminated sleep 1000  
fatima1153@DESKTOP-RMTBLBS:~$ pkill -f sleep  
fatima1153@DESKTOP-RMTBLBS:~$
```

The screenshot shows a Windows desktop with a terminal window open. The terminal displays the execution of several Linux commands: 'ps aux | grep bash' showing the current process list, 'sleep 1000 &' running a background process, 'kill 368' terminating it by PID, 'killall sleep' failing to find the process, and 'pkill -f sleep' successfully terminating it. The Windows taskbar at the bottom shows the search bar, task view button, and several application icons. The system tray on the right indicates a temperature of 36°C, sunny weather, and the time 3:57 PM on 26-Sep-25.