

Linux: System Administration



LOGISTICS



Class Hours:

- Instructor will set class start and end times.
- There will be regular breaks in class.



Telecommunication:

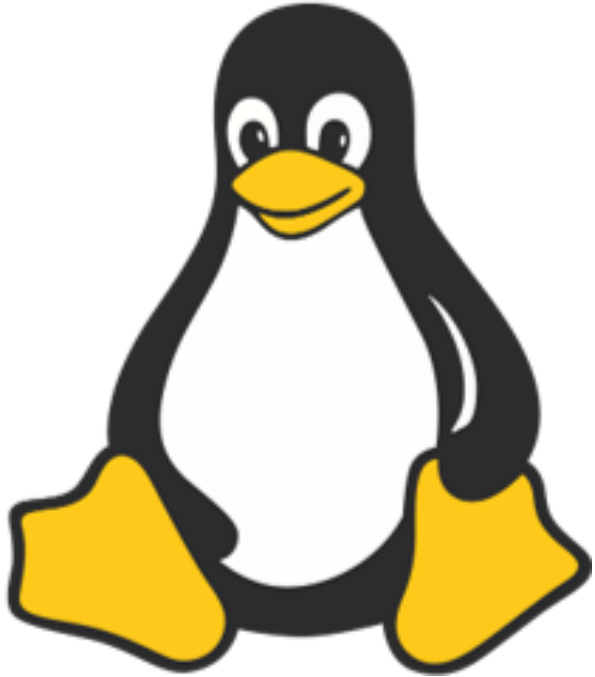
- Turn off or set electronic devices to silent (not vibrate)



Learning:

- Run the commands with the instructor as the slides are presented to you
- Ask questions and participate

Day 3 Objectives



1. Create and execute basic scripts
2. Manage and create users, groups and permissions
3. Find files based on different properties

Linux: Scripting

Scripting is a Core System Administration Skill

- Scripts let you **automate repetitive tasks**, saving time and reducing errors.
 - They make your work **consistent and repeatable**, especially across multiple systems.
 - Many administrative tasks — backups, updates, monitoring — can be run **unattended** through scripts.
 - Understanding scripting helps you **read, modify, and troubleshoot** automation others have written.
- 💡 *A good admin doesn't just run commands — they build tools that run them automatically.*



Linux: Scripting

The Shebang (#!)

The **first line** of every script is called the **shebang**. It tells the system **which interpreter** should execute the script.

Examples:

```
#!/bin/bash    # Use Bash (most common)
#!/bin/sh      # POSIX shell, for older systems
#!/bin/zsh     # Z shell
#!/usr/bin/python3 # Python script
```

💡 *The shebang defines how your script runs — even if the user's default shell is different.*

In this course, we'll be using:

```
#!/bin/bash
```



Linux: Scripting

`echo` prints text or variable values to the terminal.

```
echo "Hello World"  
echo "Today is a great day!"
```

You can also **insert command output** inside strings using a **subshell**:

```
echo "The date is $(date)"  
echo "Your current directory is `pwd`"
```

Both `$()` and backticks `` run the command inside a **subshell**, replacing it with the output.

💡 *Use subshells to make your output dynamic — commands inside them execute first, and their results are printed.*



Linux: Scripting

Creating and Using Variables

Variables store values for later use in scripts or commands.

```
name="penguin"  
echo "Hello $name"
```

- No spaces around = when assigning.
- Use \$variable to reference its value.

```
count=5  
echo "Count is $count"
```

💡 *Variables make scripts flexible and reusable.*

Linux: Scripting

Exporting and Subshell Assignment

export makes a variable available to **child processes** (like other scripts or commands).

```
export PATH=$PATH:/opt/bin
```

You can also assign values using **subshells**:

```
today=$(date)  
echo "Today is $today"
```

💡 *Use subshells when a variable should store the result of a command.*



Linux: Scripting

Viewing Environment Variables

You can see which variables are available in your shell environment:

Shows all **exported variables** — these are available to **child processes**.

```
export -p
```

Displays all **environment variables** currently set for your session.

```
printenv
```

Remember – If you create variables in your shell, they will not persist. If you want them to persist, create them in your `.bashrc` or `.bash_profile` (or other profile files)

💡 *Use these commands to inspect what's in your environment — great for debugging scripts or checking paths.*

Linux: Scripting

Quoting and Shell Expansion Tricks

Double quotes (" ") allow variable expansion;
Single quotes (' ') do not.

```
echo "Hello $USER" # expands and prints variables value  
echo 'Hello $USER' # literal text, prints $USER
```

Useful expansions:

```
echo "Home: $HOME"  
echo "Files: $(ls *.sh)"
```

💡 *Double quotes protect text but still expand variables; single quotes print exactly what you type.*

Linux: Scripting

Shell Expansion Tricks

You can manipulate variables directly in the shell using **parameter expansion** — no extra commands needed.

Set a default value (if empty):

```
echo "User: ${USER:-guest}"
```

Prints \$USER if set, otherwise prints **guest**.

Get the length of a variable:

```
name="Daniel"
```

```
echo ${#name} # 6
```

Substring (start, length):

```
word="abcdef"
```

```
echo ${word:2:3} # cde
```

Linux: Scripting

Shell Expansion Tricks

Substitute text within a variable:

```
file="report.txt"  
echo ${file/.txt/.log} # report.log
```

Remove part of a string:

```
file="report.txt"  
echo ${file%.txt} # report
```

💡 *Parameter expansion lets you format, trim, and modify data right inside your scripts — no external tools needed.*

Linux: Scripting

Special Shell Variables

Scripts can access built-in variables that provide context about how they're run.

Variable	Description
\$0	Name of the current script
\$1, \$2, ...	Positional arguments passed to the script
\$#	Number of arguments
\$@	All arguments as a single list
\$\$	Process ID (PID) of the current process
\$?	Exit code of the last command

Example:

```
echo "Running $0 with $# arguments."
```

💡 *These variables make your scripts dynamic — they adapt to input, track processes, and handle results automatically.*

Linux: Scripting

Arithmetic in Bash

You can perform basic math directly in the shell:

```
echo $((5 + 3))    # 8
```

```
echo $((10 / 2))   # 5
```

- Works for integers only (no decimals).

For **floating point math**, use `bc`:

```
echo $(bc <<< "5.5 / 2") # 2.75
```

💡 *Use `$(())` for quick integer math
`bc` for precise decimal calculations.*



Linux: Scripting

The test Command

The **test** command checks conditions — such as file existence, string comparison, or numeric values — and returns an **exit code** (0 = true, non-zero = false). Read the manual to see all the different test you can perform!

Examples:

```
test 5 -gt 3      # true
test -f /etc/passwd # true if file exists
test "$USER" = "root"
```

You can also use the **shortcut syntax**:

```
[ 5 -gt 3 ]
[ "$USER" != "root" ]
```

💡 *test is how Bash makes decisions — it powers conditionals like if and while.*

Linux: Scripting

Using if / else Statements

The **if statement** runs commands based on a condition's success or failure. When you use `[]`, you're actually using the **test command** behind the scenes.

Example:

```
if [ "$USER" = "root" ]; then
    echo "You are the root user."
else
    echo "You are not root."
fi
```

- `[condition]` is just shorthand for test condition
- then executes if the exit code is **0 (true)**

💡 *Every if checks a command's success — [just happens to be one.*

Linux: Scripting

Any Command Can Be Used in if

You can use **any command** in an if statement
If the command **succeeds (exit code 0)**, the then block runs.

Examples:

```
if grep -q "error" /var/log/syslog; then  
    echo "Errors found!"  
else  
    echo "No errors detected."  
fi
```

```
if ping -c1 google.com >/dev/null 2>&1; then  
    echo "Network is up!"  
else  
    echo "Network is down!"  
fi
```



Linux: Scripting

The Extended Test Command – [[]]

`[[...]]` is a **modern version** of the test command — safer, more powerful, and easier to read.

It supports:

- String comparisons (`=`, `!=`)
- Numeric comparisons (`-eq`, `-gt`, etc.)
- Pattern matching and basic regex with `=~`

Examples:

```
if [[ "$USER" == "Mike" ]]; then
    echo "Welcome, Mike!"
fi
```

```
if [[ "filename.txt" =~ \.txt$ ]]; then
    echo "This is a text file."
fi
```

💡 *`[[]]` is preferred in Bash — it adds pattern matching, regex, and prevents common quoting errors.*



Linux: Scripting

Using elif and else

You can chain multiple conditions using **elif** (else if) and finish with **else** for all remaining cases.

Example:

```
if [ "$USER" = "root" ]; then
    echo "You are root."
elif [ "$USER" = "admin" ]; then
    echo "Hello Admin!"
else
    echo "Standard user access."
fi
```

- The shell checks each condition **in order** until one succeeds.
- Only the **first true condition** runs — the rest are skipped.

💡 *Use elif to handle multiple outcomes cleanly without stacking nested if statements.*

Linux: Scripting

The case Statement


The **case** statement is used for matching **multiple patterns** — a cleaner alternative to long if/elif chains.

Example:

```
read -p "Enter a number: " num
```

```
case $num in
  1) echo "One";;
  2) echo "Two";;
  3) echo "Three";;
  *) echo "Invalid choice";;
esac
```

- Each pattern ends with) and each action ends with ;;.
- The * pattern acts as a **default** (like else).

 *Use case when you have several clear options — it's more readable and faster to maintain than nested if statements.*

Linux: Scripting

The while Loop

A **while** loop runs as long as its condition is **true**.

```
count=1
while [ $count -le 5 ]; do
  echo "Count: $count";
  ((count++))
done
```

Prints numbers **1 through 5**, one per line.

Use **until** for the opposite behavior:

```
until [ $count -gt 5 ]; do ...
```

Runs **until** the condition becomes true.

💡 *Great for counters, checks, and continuous monitoring loops.*

Linux: Scripting

The for Loop

A **for loop** iterates over a list of items — words, numbers, or files.

```
for item in apple banana cherry; do  
    echo "Fruit: $item"  
done
```

The loop separates items using the **Internal Field Separator (IFS)** — by default, it's **whitespace** (spaces, tabs, newlines).

```
IFS='';  
for item in one,two,three; do  
    echo $item;  
Done
```

```
IFS=$' \t\n' # reset to default
```

💡 *Understanding and resetting IFS ensures consistent behavior when processing text or input.*

Linux: Scripting

More for Loop Styles

You can loop over **ranges** and even use **C-style syntax** in Bash.

Brace Expansion (Numbers & Letters):

```
for i in {1..5}; do  
    echo "Number: $i"  
done
```

```
for letter in {a..e}; do  
    echo "Letter: $letter"  
done
```

C-Style Loop:

```
for ((i=1; i<=5; i++)); do  
    echo "Count: $i"  
done
```

💡 *Brace expansion is simple and fast; C-style loops give you full control over counters and conditions.*

Linux: Scripting

Arrays in Bash

Arrays let you store and manage multiple values in one variable.

```
# Create an array
colors=("red" "green" "blue")

# Access elements
echo ${colors[0]}      # red

# Show all elements
echo ${colors[@]}

# Number of elements
echo ${#colors[@]}

# Add a new item
colors+=("yellow")

# Remove an item by index
unset 'colors[1]'      # removes "green"
```

💡 Arrays make it easy to organize and loop through lists of values dynamically.

Linux: Scripting

Looping Over an Array

You can iterate through array elements with a simple **for** loop:

```
colors=("red" "green" "blue")
```

```
for color in "${colors[@]}; do  
    echo "Color: $color"  
done
```

💡 Always quote "\${array[@]}" — this preserves spaces and prevents word-splitting issues.


Linux: Scripting

Looping Over Script Arguments (\$@)

\$@ expands to **all arguments** passed to a script — perfect for looping through input values dynamically.

```
#!/bin/bash  
echo "You passed $# arguments."
```

```
for arg in "$@"; do  
    echo "Argument: $arg"  
done
```

 \$# gives the **count** of arguments, and \$1, \$2, etc. give individual ones. This is how scripts accept user input or process multiple files in one go.



Linux: Scripting

⚙️ Functions in Bash

A **function** is like creating your own **command** — you call it and pass arguments just like any other command.

```
greet() {  
  echo "Hello, $1"  
  return 0  
}
```

```
greet penguin    # runs the function
```

💡 Arguments work like \$1, \$2, @\$ — just like in scripts.



Linux: Scripting

Return vs Output

- return only sets an **exit status**
 - (0 = success, non-zero = error).
- To capture output, **echo** it and store it in a **subshell**:

```
get_name() {  
    echo "penguin"  
    return 0  
}
```

```
name=$(get_name)  
echo "Name is $name"
```

💡 *Use return for success/failure — use echo for data.*



Linux: Scripting

Error Handling with set Options

You can make your scripts **safer and more predictable** by enabling strict error handling.

```
#!/bin/bash
```

```
# Exit immediately if any command fails  
set -e
```

```
# Treat undefined variables as errors  
set -u
```

```
# Fail if any command in a pipeline fails  
set -o pipefail
```

These options help catch mistakes early and prevent scripts from continuing in an unstable state.

💡 *Use strict modes in production scripts — they turn silent bugs into visible errors.*



Linux: Scripting

Running Commands with `bash -c`

You can run a **command** or **small script** directly from the command line using `bash -c`.

```
bash -c "echo Hello from Bash!"
```

This starts a **new Bash shell**, runs the command inside the quotes, then exits.

You can also chain commands:

```
bash -c "cd /tmp && ls"
```

💡 *Useful for one-liners, automation, or testing script logic without creating a file.*

Lab 3.1 Scripting Basics / Challenge

Estimated Time: 25



POP QUIZ:

What is the shell variable \$#?

- A. Number of arguments to the script
- B. An array of arguments to the script
- C. The name of the script
- D. Internal Field Separator



POP QUIZ:

What is the shell variable \$#?

- A. Number of arguments to the script
- B. An array of arguments to the script
- C. The name of the script
- D. Internal Field Separator

"What variables represent the other options?"



POP QUIZ:

What is an alias to the test command?

- A. if
- B. []
- C. ttest
- D. There is none



POP QUIZ:

What is an alias to the test command?

- A. if
- B. ☐
- C. ttest
- D. There is none

"What kind of test can we run?"



Linux: Users, Groups and Permissions

User and group management is at the heart of Linux security and organization. It defines who can access the system, what they can do, and which files or resources they can modify. Without proper user and group control, even a well-configured system can become vulnerable or chaotic.

A good administrator doesn't rely on chance — they enforce structure. Understanding users, groups, and permissions means you can protect data, delegate responsibilities safely, and maintain a stable, secure environment for everyone on the system.



Linux: Users, Groups and Permissions

Checking User Information

You can verify your identity and group memberships using these simple commands:

Shows your **current logged-in username**.

`whoami`

Displays your **user ID (UID)**, **group ID (GID)**, and **all groups** you belong to.

`id`

Lists all **groups** associated with your user account.

`groups`

Prints your **username** from the environment variable.

`echo $USER`

💡 *These commands help confirm who you are, what privileges you have, and which groups you belong to.*



Linux: Users, Groups and Permissions

Viewing All Users and Groups

View every **user** and **group** configured on the system.

List all users:

```
cat /etc/passwd
```

List all groups:

```
cat /etc/group
```

💡 *Each line in these files represents a user or group entry used by Linux for authentication and permissions.*

Linux: Users, Groups and Permissions

Creating Users and Groups

Create a new user and group, then verify:

```
sudo useradd -m penguin # -m is short for --create-home  
sudo groupadd developers  
sudo usermod -aG developers penguin
```

```
id penguin
```

- useradd → creates a new user
- groupadd → creates a new group
- usermod -aG → adds user to group
- id → verifies group membership

💡 *Always verify your changes — users, groups, and permissions form the foundation of system security.*

Linux: Users, Groups and Permissions

Switching Users and Managing Passwords

You can switch to another user account (even without their password if you have sudo access):

Starts a new shell as **penguin**, loading their environment.

```
sudo su - penguin
```

Returns to your original user.

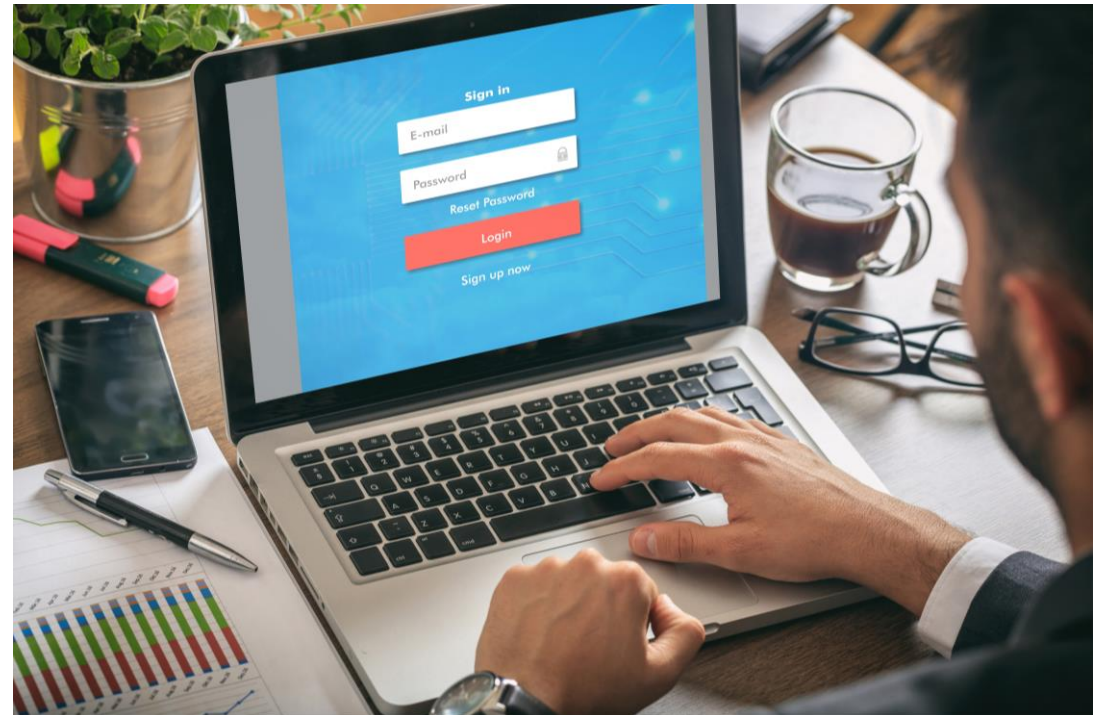
```
exit
```

Change a user's password:

```
passwd penguin
```

On most servers, **password logins are disabled** — users authenticate with **SSH keys** instead, stored in: `~/.ssh/authorized_keys`

💡 *SSH key authentication is more secure than passwords and preferred in production systems.*



Linux: Users, Groups and Permissions

Removing Users and Groups

Delete a User

```
# sudo userdel penguin
```

To delete everything (home + mail + files):

```
sudo userdel -r penguin
```

Delete the groups (most Linux systems create a group when creating a user)

```
sudo groupdel penguin
```

```
sudo groupdel developers
```

Removes the **group** entry.

Make sure no active user or process is still assigned to it.

💡 *Always verify before deleting*



Linux: Users, Groups and Permissions

Checking & Disabling SSH Password Authentication

Quickly check the SSH server config for the password auth setting:

```
sudo grep -i "PasswordAuthentication" /etc/ssh/sshd_config
```

If present and set to no, password logins are disabled for SSH:

```
# Explicitly disable PasswordAuthentication.
```

```
PasswordAuthentication no
```

💡 *You can turn this setting **off** (i.e., set to no) to require key-based SSH authentication. After changing this setting you would need to restart sshd. For the purpose of this class, we will not modify this setting. In production environments, password authentication should be turned off.*

Linux: Users, Groups and Permissions

Root Login and sudo su

You can escalate to root locally with:

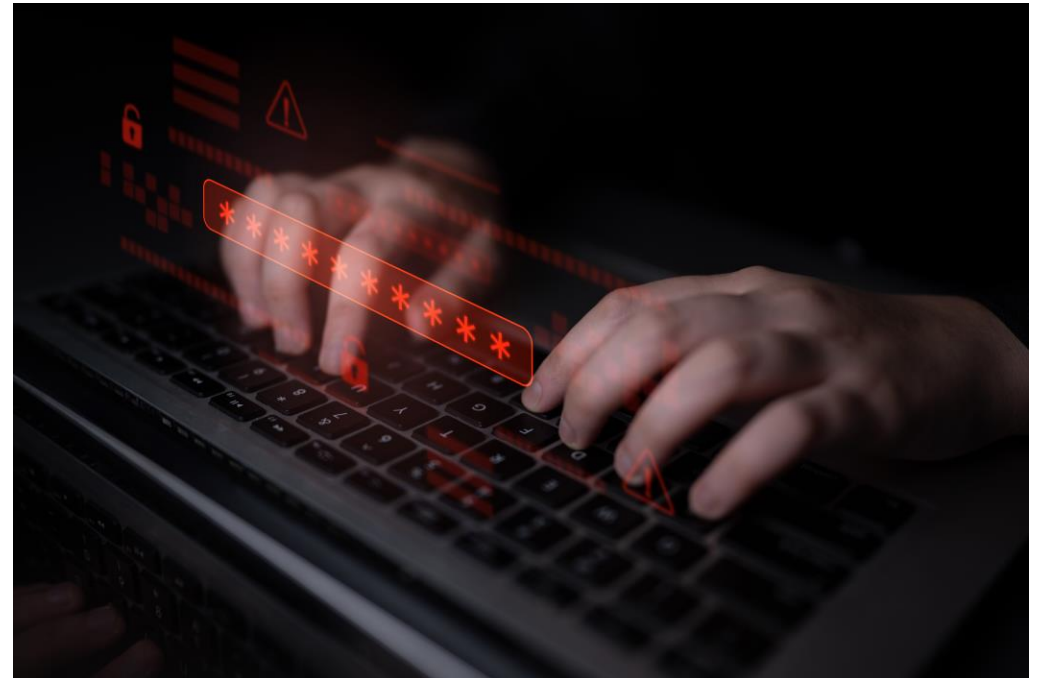
```
[ec2-user@ip-172-31-1-87 ~]$ sudo su - root  
[root@ip-172-31-1-87 ~]# exit  
[ec2-user@ip-172-31-1-87 ~]$
```

Notice that when you are **root**, the prompt ends with **#** instead of **\$**.

Even if SSH password authentication is disabled, users with **sudo privileges** can still become root if their sudo rights allow it.

Restrict which commands users may run via sudoers (e.g., do not give su command) and disable password logins.

💡 *Combining both gives you stronger local privilege control. We will cover sudoers later in course.*



Linux: Users, Groups and Permissions

Symbol	Permission	Description	Numeric Value
r	Read	Can view or read file	4
w	Write	Modify or delete file	2
x	Execute	Can execute the file	1
-	No Permission	No access	0

```
[ec2-user@ip-172-31-1-87 ~]$ ls -l
total 0
drwxr-xr-x. 2 ec2-user ec2-user 6 Oct 21 16:48 test-dir
-rw-r--r--. 1 ec2-user ec2-user 0 Oct 21 16:48 test.txt
```

Linux: Users, Groups and Permissions

Changing Permissions – Relative (Symbolic)

Modify permissions **relative to current settings**.

```
chmod u+r file.txt    # Add read for user
chmod g-x file.txt    # Remove execute for group
chmod a+rx file.txt    # Add read & execute for everyone
chmod u+x,g-x,o-rw file.sh # Multiple changes in one command
```

u = user **g** = group **o** = others **a** = all
+ add - remove = set exactly

 *Use relative when tweaking existing permissions.*

Linux: Users, Groups and Permissions

Changing Permissions – Absolute (Numeric)

Set all permissions **explicitly** using numbers.
`chmod 744 script.sh`

Breakdown:

- 7 (rwx) → user
- 4 (r--) → group
- 4 (r--) → others

💡 *Use absolute when standardizing (e.g., 644 for files, 755 for scripts).*



Linux: Users, Groups and Permissions

The Sticky Bit (t)

The **sticky bit** restricts **who can delete files** inside a shared directory. Even if you have write permissions to the directory, you **can't delete or rename files you don't own** when the sticky bit is set.

Example: /tmp Directory

```
ls -ld /tmp
```

```
drwxrwxrwt. 10 root root 4096 Oct 26 13:00 /tmp
```

Notice the **t** at the end — that's the sticky bit.

It means only the **file owner** (or **root**) can delete their own files here.

Set or Remove It Manually

```
chmod +t shared_dir    # Add sticky bit
```

```
chmod -t shared_dir    # Remove sticky bit
```

 *Used for shared folders like /tmp to prevent users from deleting each other's files.*

Linux: Users, Groups and Permissions

SetUID and SetGID

These special permission bits let a program **run with the privileges of its owner or group**, not the user who runs it.

Example

```
ls -l /usr/bin/passwd  
-rwsr-xr-x 1 root root 54256 Oct 26  passwd
```

- The **s** in the user field → **SetUID** (runs as the file's owner — here, root)
- The **s** in the group field → **SetGID** (runs with the file's group privileges)

If an executable with **SetUID root** is compromised, it can grant attackers **root-level access**.

```
chmod u+s file  # Add SetUID  
chmod g+s file  # Add SetGID  
chmod u-s g-s file  # Remove them
```

 *Only trusted system binaries (like passwd) should ever use SetUID/SetGID.*

Linux: Users, Groups and Permissions

Common File Permission Standards

File / Folder Type	Recommended chmod	Purpose / Rationale
Private SSH Key (~/.ssh/id_rsa)	600 or 400	Owner-only access; SSH refuses keys that are too open
.ssh Directory (~/.ssh/)	700	Only the owner can read, write, or enter
Executable / Script (script.sh)	755	Owner can edit; others can run but not modify
Configuration / Text Files (*.conf, *.txt)	644	Owner read/write; others read-only
Shared Directory (/shared, /var/www/html)	775	Group collaboration allowed; public read/execute
Temporary Directory (/tmp)	1777	World-writable but protected by sticky bit (t)

 **Tip:** Follow *least privilege* — grant only the access users truly need.

Lab 3.2 Users, Groups and Permissions

Estimated Time: 30 Minutes



POP QUIZ:

What command is used to add a user to a group?

- A. `user -a -G developers penguin`
- B. `useradd -G developers penguin`
- C. `usermod -a -G developers penguin`
- D. All options are valid



POP QUIZ:

What command is used to add a user to a group?

"What are -a and -G for?"

- A. user -a -G developers penguin
- B. useradd -G developers penguin
- C. **usermod -a -G developers penguin**
- D. All options are valid



POP QUIZ:

What command can remove write permissions from group, and add write to file owner?

- A. `chmod 777`
- B. `chmod 200`
- C. `chmod g-w,o+w`
- D. `chmod g-w,u+w`



POP QUIZ:

What command can remove write permissions from group, and add write to file owner?

- A. `chmod 777`
- B. `chmod 200`
- C. `chmod g-w,o+w`
- D. `chmod g-w,u+w`

"Why can't we use the numbers here?"



POP QUIZ:

Which command will modify permissions for a key file so that it can be used by ssh?

- A. chmod 600
- B. chmod 777
- C. chmod 644
- D. chmod 640



POP QUIZ:

Which command will modify permissions for a key file so that it can be used by ssh?

- A. `chmod 600`
- B. `chmod 777`
- C. `chmod 644`
- D. `chmod 640`

"What error will you get with the other permissions?"



POP QUIZ:

Suppose you are part of the admin group. Will you be able to execute a file in the admin group with 701 permission?

- A. No, permissions are read from left to right
- B. Yes, since others can execute
- C. Only if you are not a other user
- D. Only if you it has sticky bit



POP QUIZ:

Suppose you are part of the admin group. Will you be able to execute a file in the admin group with 701 permission?

- A. No, permissions are read from left to right
- B. Yes, since others can execute
- C. Only if you are not a "other" user "What if you use sudo?"
- D. Only if you it has sticky bit



Linux: Finding Files

The find command lets administrators locate files anywhere on the system using powerful filters — by name, size, ownership, modification time, or even permissions. It's an essential tool for quickly pinpointing misplaced configs, outdated logs, or insecure files without guesswork.

A skilled admin uses find not only to locate files but to audit and secure the system — spotting files with world-writable permissions, tracking down recently changed scripts, or cleaning up old data. It's precision search for keeping systems organized, efficient, and safe.



Linux: Finding Files

Introduction to find

The find command searches your filesystem for files and directories that match specific criteria — starting from any path you choose.

Let's start simple inside your **home directory** (~):

```
cd ~
```

```
# Create some files
```

```
touch 1.txt 2.txt 3.sh
```

```
# Find a specific file
```

```
find ~ -name 3.sh
```

```
# Find all .txt files (case-sensitive)
```

```
find ~ -name "*.txt"
```

find automatically searches **recursively**, scanning all subdirectories within your chosen path.

Once you master the basics, you can filter by **date**, **size**, or **permissions** to find exactly what you need.



Linux: Finding Files

Common find Filters

The find command supports powerful filters that let you narrow or expand your search results.

Find only directories

```
find ~ -type d
```

Find by name (case-insensitive)

```
find ~ -iname "*.sh"
```

Find all .txt files except 2.txt


```
find ~ -name "*.txt" ! -name "2.txt"
```

Find .sh OR .txt files with Grouped Expression

```
find ~ \( -name "*.sh" -o -name "*.txt" \)
```

Key Filters:

- -type → search by file type (f = file, d = directory)
- -iname → case-insensitive name match
- ! → negate a condition (NOT)
- -o → OR operator

 Combine filters to create precise searches — find is as flexible as a mini query language for your filesystem.



Linux: Finding Files

💡 *How can we find all configuration files in /etc?*

```
[ec2-user@ip-172-31-1-87 ~]$ sudo find /etc/ -iname "*.conf" -type f
/etc/dracut.conf.d/ec2.conf
/etc/dnf/plugins/release-notification.conf
/etc/dnf/plugins/copr.conf
/etc/dnf/plugins/debuginfo-install.conf
/etc/dnf/dnf.conf
/etc/dnf/protected.d/dnf.conf
/etc/dnf/protected.d/grub2-tools-minimal.conf
/etc/dnf/protected.d/systemd.conf
/etc/dnf/protected.d/sudo.conf
/etc/dnf/protected.d/grub2-efi-x64-ec2.conf
/etc/pki/ca-trust/ca-legacy.conf
/etc/host.conf
/etc/ld.so.conf
/etc/ld.so.conf.d/dyninst-x86_64.conf
/etc/nsswitch.conf
/etc/xattr.conf
/etc/libaudit.conf
/etc/selinux/semanage.conf
/etc/selinux/targeted/setrans.conf
/etc/request-key.conf
/etc/request-key.d/id_resolver.conf
/etc/dbus-1/session.conf
/etc/dbus-1/system.conf
```



Linux: Finding Files

Searching the Entire Filesystem

When searching from `/`, you may encounter system files and special directories like `/proc` or `/sys`, which can generate lots of error messages.

To keep your output clean, you can redirect those errors to `/dev/null`:

```
sudo find / -name "hosts" 2>/dev/null
```

 `2>` redirects **error output (stderr)** so you only see real results.

This is useful for full-system searches where some paths may be inaccessible or noisy.



Linux: Finding Files

Finding Files by Permission

System administrators often search for files with **insecure or specific permissions** to audit the system.

The `-perm` option lets you match files by their permission bits.

Find files with 777 permissions (world-readable, writable, executable)

```
find ~ -perm 777
```

Find files writable by others (world-writable)

```
find ~ -perm -o=w
```

Find files that are not world-writable

```
find ~ ! -perm -o=w
```

Key Flags:

- `-perm 777` → exact match
- `-perm -o=w` → at least world-writable
- `!` → negate condition (NOT)

Linux: Finding Files

Finding Insecure or Sensitive Files


System administrators can use `find` to detect **potentially dangerous** or **misconfigured** files — such as those with special permissions or exposed private keys.

```
# Find files with SUID (-4000) or SGID (-2000) owned by root
sudo find /usr -type f \( -perm -4000 -o -perm -2000 \) -user root 2>/dev/null
```

SUID/SGID executables run with elevated privileges and should be reviewed for security risks.

You can also scan for **private key files** with insecure permissions:

```
find ~ -type f -name "*.pem" ! -perm 600
```

 PEM keys should normally be 600 (read/write for owner only).

This helps you identify any that are too open and could be accessed by others.

Linux: Finding Files

Finding Files by Size

The `-size` option lets you locate files based on their size — useful for finding **large logs**, **backups**, or **unusually small files**.

Find files larger than 100MB

```
find ~ -type f -size +100M
```

Find files smaller than 1KB

```
find ~ -type f -size -1k
```

Find files exactly 10MB

```
find ~ -type f -size 10M
```

Suffixes:

- k → kilobytes
- M → megabytes
- G → gigabytes



Linux: Finding Files

Finding and Removing Empty Files

The `-empty` option finds **empty files or directories**, and when combined with `-delete`, it can quickly clean up unused space.

```
# Find and delete empty files  
find ~ -type f -empty -delete
```

💡 *Use with caution!* `-delete` permanently removes anything that matches — there's **no undo**.



Linux: Finding Files

Time-Based Search Options

find can filter files based on **when they were modified, accessed, or changed** — great for log rotation, cleanup, and audits.

Option	Unit	Description
-mtime	days	File content modified (M = modify)
-mmin	minutes	Same as above, in minutes
-atime	days	File accessed (read)
-amin	minutes	Same as above, in minutes
-ctime	days	File metadata changed (permissions, owner, etc.)
-cmin	minutes	Same as above, in minutes

 Use these to find files by their activity — whether for cleanup, backup, or security analysis.

Linux: Finding Files

Examples – Time-Based Searches

Files modified in the last 24 hours

```
find ~ -type f -mtime -1
```

Files not accessed in 30 days

```
find ~ -type f -atime +30
```

Files whose permissions or ownership changed recently

```
find /etc -type f -ctime -2
```

Files modified within the last 10 minutes

```
find /var/log -type f -mmin -10
```

When servers break, a good strategy for troubleshooting is to look for configuration files that had recent changes

 + means **older than**, - means **newer than**, and no sign means **exactly** that time span.

Linux: Finding Files

Using -exec with find

The **-exec** option lets you perform actions on files found by find — powerful for **batch operations** like inspection, cleanup, or fixing permissions.

```
find . -name "*.log" -exec ls -lh {} \;
```

Each {} represents the **current file**, and \; ends the command after each file.

Variants:

- -exec command {} \; → runs the command **once per file**
- -exec command {} + → runs the command **once with all files as arguments** (faster and more efficient)

Note: The + must appear at the **end of the command**, just like \;, but without the backslash.

Linux: Finding Files

Fixing Insecure File Permissions

You can use find with -exec to locate and correct **world-writable (777)** files.

This is a common **security hardening task** for system administrators.

Find all files with 777 permissions


```
find ~ -type f -perm 777 -ls
```

Change them to 644 (owner read/write, others read-only)

```
find ~ -type f -perm 777 -exec chmod 644 {} \;
```

Verify the fix

```
find ~ -type f -perm 644 -ls
```

 -perm 777 finds files where **anyone can modify or execute** — changing them to **644** helps protect integrity while keeping readability.

Linux: Finding Files

Searching *Inside* Files with grep

While find locates files by **attributes**, it doesn't look **inside** them.

To search for text patterns — like “*Error*” messages or configuration settings — use **grep**.

```
# Search all files in /var/log for the word "error"  
grep -lri "error" /var/log
```

Options explained:

- **-l** → show only filenames that contain matches
- **-r** → search recursively through directories
- **-i** → ignore case (matches “*Error*”, “*ERROR*”, “*error*”, etc.)



Lab 3.3 Finding Files

Estimated Time: 30 Minutes



POP QUIZ:

Which command can be used to find files with "http-proxy:enabled" in the file?

- A. `grep "http-proxy:enabled"`
- B. `find -search "http-proxy:enabled"`
- C. `locate "http-proxy:enabled"`
- D. `grep -rl "http-proxy:enabled"`



POP QUIZ:

Which command can be used to find files with "http-proxy:enabled" in the file?

- A. `grep "http-proxy:enabled"`
- B. `find -search "http-proxy:enabled"`
- C. `locate "http-proxy:enabled"`
- D. `grep -rl "http-proxy:enabled"`

"Why are the flags needed?"



POP QUIZ:

How can we print the contents of every file ending in txt?

- A. `find -type f -name "*.txt" -exec cat {} +`
- B. `find -type f -name "*.txt" -exec cat {} ;`
- C. `cat *.txt`
- D. `grep -rl "*.txt" | cat`



POP QUIZ:

How can we print the contents of every file ending in txt?

- A. `find -type f -name "*.txt" -exec cat {} +`
- B. `find -type f -name "*.txt" -exec cat {} ;`
- C. `cat *.txt`
- D. `grep -rl "*.txt" | cat`

"Why does `cat *.txt` not work for every file?"



POP QUIZ:

Suppose a user (penguin) was deleted and we want to find and delete any file belonging to them. Which command will do so?

- A. `find -type f -user penguin -exec rm`
- B. `find -type f -user penguin -rm`
- C. `find -type f -user penguin -delete`
- D. `userdel penguin -files`



POP QUIZ:

Suppose a user (penguin) was deleted and we want to find and delete any file belonging to them. Which command will do so?

- A. `find -type f -user penguin -exec rm`
- B. `find -type f -user penguin -rm`
- C. `find -type f -user penguin -delete`
- D. `userdel penguin -files`

"Why does `cat *.txt` not work for every file?"



POP QUIZ:

A Web Server is not working as 30 minutes ago. You want to investigate for recent changes. Which command may help you?

- A. `find /etc -time -60m`
- B. `find /etc -mmin 60`
- C. `find /etc -type f -mtime -60`
- D. `find /etc -type f -mmin -60`



POP QUIZ:

A Web Server is not working as 30 minutes ago. You want to investigate for recent changes. Which command may help you?

- A. `find /etc -time -60m`
- B. `find /etc -mmin 60`
- C. `find /etc -type f -mtime -60`
- D. `find /etc -type f -mmin -60`

"What do each of these options do differently?"



Lab 3.4 Find Scripting Challenge

Estimated Time: 60 Minutes



Linux Day 3 Complete

🎉 Great Work Today!

Today you learned how to:

- Write and run **Bash scripts** with variables, loops, arrays, and functions
- Create and manage **users, groups, and permissions** to secure your system
- Use tools like **find** and **grep** to locate files by attributes or content

Give yourself a pat on the back — you've taken another big step toward becoming a **confident and capable Linux Administrator**.

💡 Keep practicing — the more you script, manage, and explore, the more Linux starts working *for you* instead of the other way around.

