

# CSS 262: Linux Administration


## \*nix Systems for Cybersecurity

### Lecture 1: Course Introduction & The Shell



# Welcome to CSS 262

- **What this course is about:** Linux Administration with a security-first approach
- **Who this course is for:** Future cybersecurity professionals
- **What you'll learn:** How to deploy, maintain, and secure Linux environments
- **Why it matters:** Essential skills for DevSecOps and Security Operations roles

 **Key Philosophy:** We focus on the "why" and "how" of system internals, not just commands to memorize.



# Course Details

**Course Code:** CSS 262

**Duration:** 15 Weeks

**Credits:** 5-6 ECTS

**Level:** Undergraduate

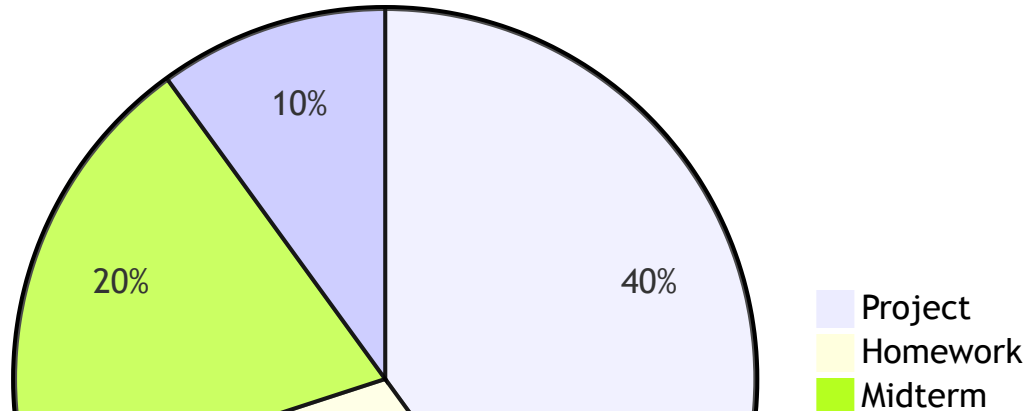


## Workload



## Grading Breakdown

### Assessment Distribution



# Course Learning Outcomes

1. **Administer** fundamental Linux components (users, permissions, storage, systemd)
2. **Develop** automated solutions using Bash scripting
3. **Configure** robust network settings and package management
4. **Harden** server security (SSH, firewalls, service management)
5. **Analyze** system logs and audit trails for security incidents
6. **Construct** production-ready infrastructure using IaC principles



# Course Journey

## Weeks 1-7: Foundations







- **Week 1:** Shell & VM Setup 🔧
- **Week 2:** Users & Permissions 👤
- **Week 3:** Processes & Systemd ⚙️
- **Week 4:** Storage & Filesystems 💾
- **Week 5:** Bash Scripting 📖
- **Week 6:** Networking Basics 🌐
- **Week 7:** Package Management 📦

## Weeks 8-15: Security Focus

- **Week 8:** 🔥 **Midterm Exam**
- **Week 9:** SSH Hardening 🔒
- **Week 10:** Firewalls 🛡️
- **Week 11:** SELinux/MAC 🗝️
- **Week 12:** Logging & Auditing 📊
- **Week 13:** Docker Security 🐳
- **Week 14:** Vuln Scanning 🔍
- **Week 15:** 🎓 **Capstone Project**

# Skills You'll Acquire

## Academic Skills

-  Problem-solving & troubleshooting
-  Critical thinking & root cause analysis
-  Research skills & documentation
-  Practical coding in Bash/Shell
-  Self-directed learning
-  Security-first mindset

## Technical Skills

- Filesystem & permission management
- Security auditing scripts
- Firewall configuration
- Mandatory Access Control (SELinux)
- Log analysis & forensics
- Systemd & LVM administration


# Required Resources

## Textbooks

1. **The Linux Command Line (2nd Edition)** - William Shotts
2. **UNIX and Linux System Administration Handbook (5th Edition)** - Evi Nemeth et al.
3. **PicoCTF Learning Primer** - For CTF-style challenges

## Hardware & Software

- **Laptop:** Minimum 8GB RAM
- **Virtualization:** VirtualBox or VMware
- **Tools:** Git, VS Code
- **Accounts:** GitHub (Free Educational Account)

 **Important:** You MUST have a working VM environment by next week's lab!

## Part 2: The Shell



Understanding the command-line interface



# What is a Shell?

## Definition

The **shell** is a command-line interpreter that provides a user interface for accessing operating system services.

## Why Command Line?

- ⚡ **Power & Efficiency:** Automate repetitive tasks
- 🎯 **Precision:** Fine-grained control over system
- 🔄 **Reproducibility:** Script your actions
- 🌐 **Remote Access:** Manage systems over SSH
- 💪 **Professional Standard:** Industry-standard for sysadmin

# Shell Types

## Common Shells

- **bash** - Bourne Again Shell (Most common)
- **zsh** - Z Shell (Modern, feature-rich)
- **sh** - Original Bourne Shell
- **fish** - Friendly Interactive Shell

## Check Your Shell

```
1  # See current shell
2  echo $SHELL
3
4  # List available shells
5  cat /etc/shells
6
7  # Change shell
8  chsh -s /bin/bash
```

## Shell in Terminal

# The Command Prompt


```
1 user@hostname:~/directory$ command [options] [arguments]
```

## Prompt Components

- `user` - Your username
- `hostname` - Computer name
- `~/directory` - Current location
- `$` - Regular user
- `#` - Root/superuser

## Special Paths

- `~` - Home directory
- `/` - Root directory
- `.` - Current directory
- `..` - Parent directory
- `-` - Previous directory

 **Pro Tip:** The prompt can be customized via the `PS1` environment variable!

# Essential Navigation Commands

## Moving Around

```
1  # Print working directory
2  pwd
3
4  # List contents
5  ls
6  ls -l    # Long format
7  ls -a    # Show hidden files
8  ls -lah  # All options combined
9
10 # Change directory
11 cd /etc
12 cd ~     # Go home
13 cd ..    # Go up one level
14 cd -     # Go to previous directory
```

## File Operations

```
1  # Create file
2  touch file.txt
3
4  # Copy files
5  cp source.txt dest.txt
6
7  # Move/rename
8  mv old.txt new.txt
9
10 # Delete
11 rm file.txt
12 rm -r directory/ # Recursive
13
14 # Create directory
15 mkdir new_folder
16 mkdir -p path/to/folder # Parents
```

# Getting Help

## 1. Manual Pages (man)

```
1  man ls          # Read the manual for ls
2  man man         # Learn about man itself!
```

## 2. Command Help

```
1  ls --help       # Quick help
2  help cd         # For built-in commands
```

## 3. Type and Which

```
1  type ls         # Show command type
2  which python    # Show command location
```

## 4. Info Pages

```
1  info coreutils  # GNU info system
```



**Learning Skill:** Reading man pages is a critical skill you'll use throughout your career!

# File System Hierarchy

1	/	Root directory
2	— bin/	Essential user binaries
3	— boot/	Boot loader files
4	— dev/	Device files
5	— etc/	System configuration
6	— home/	User home directories
7	— root/	Root user's home
8	— tmp/	Temporary files
9	— usr/	User programs
10	— bin/	User binaries
11	— local/	Locally installed
12	— var/	Variable data (logs, etc.)

💡 **Everything in Linux is a file!** Including devices, processes, and network sockets.

# Command Structure & Syntax

## Basic Anatomy

```
1  command [options] [arguments]
```

- **Command:** The program to run (e.g., `ls`, `cat`, `grep`)
- **Options:** Modify behavior (e.g., `-l`, `--all`, `-R`)
- **Arguments:** What to operate on (e.g., files, directories)

## Examples

```
1  ls -l /home/user           # List in long format
2  cp -r source/ destination/ # Copy recursively
3  grep -i "error" /var/log/syslog # Case-insensitive
```

⚠️ **\*\*Remember:\*\*** Options can be combined: ``ls -lah` = `ls -l -a -h``

# Keyboard Shortcuts

## Navigation & Editing

- `Ctrl + A` / `Ctrl + E` - Line start/end
- `Ctrl + ←/→` - Jump by word
- `Ctrl + K` - Cut to end of line
- `Ctrl + U` - Cut to start of line
- `Ctrl + W` - Delete previous word

## Control

- `Ctrl + C` - Interrupt command
- `Ctrl + D` - Exit/logout
- `Ctrl + Z` - Suspend process
- `Ctrl + L` - Clear screen

## History Navigation

- `↑/↓` - Browse history
- `Ctrl + R` - Reverse search
- `history` - Show all commands
- `!!` - Repeat last command
- `!n` - Run command #n

## Pro Tips

- Press `Tab` for autocomplete
- Double `Tab` for all options
- `Esc + .` - Last argument



# Viewing File Contents

## Basic Viewing

```
1  cat file.txt           # Display entire file
2  less file.txt          # Paginated viewer (q to quit)
3  head file.txt          # First 10 lines
4  head -n 20 file.txt    # First 20 lines
5  tail file.txt          # Last 10 lines
6  tail -f /var/log/syslog # Follow in real-time
```

## Text Search

```
1  grep "pattern" file.txt      # Search for pattern
2  grep -r "error" /var/log/    # Recursive search
3  grep -i "warning" file.txt   # Case-insensitive
```

# Pipes and Redirection

## Redirection Operators

```
1  command > file.txt      # Redirect output (overwrite)
2  command >> file.txt     # Redirect output (append)
3  command < file.txt      # Redirect input
4  command 2> errors.txt   # Redirect stderr
5  command &> all.txt      # Redirect stdout + stderr
```

## Pipes (|)

```
1  ls -l | grep ".txt"     # List only .txt files
2  cat /var/log/syslog | grep error | less # Chain commands
3  ps aux | grep apache | wc -l      # Count processes
```



**\*\*Unix Philosophy:\*\*** Write programs that do one thing well and work together via pipes.

# Wildcards & Pattern Matching

## Glob Patterns

```
1  *           # Matches any characters
2  ?           # Matches single character
3  [abc]       # Matches a, b, or c
4  [a-z]       # Matches any lowercase letter
5  [!abc]      # Matches anything except a, b, or c
```

## Examples

```
1  ls *.txt           # All .txt files
2  ls file?.txt       # file1.txt, fileA.txt, etc.
3  ls [a-c]*          # Files starting with a, b, or c
4  rm *~              # Delete backup files
5  cp /etc/*.conf ./  # Copy all .conf files
```

⚠️ **Warning:** Be careful with `rm *` - it deletes everything!

# Environment Variables

## What are they?

Variables that affect how processes run on your system.

```
1  # View variables
2  env                # View all
3  echo $HOME         # View specific
4
5  # Set variable
6  MY_VAR="Hello"
7  export MY_VAR="Hello" # Export for child processes
```

## Common Variables

- `$HOME` - Home directory
- `$USER` - Username
- `$PATH` - Command search path
- `$SHELL` - Current shell
- `$PWD` - Current directory

## More Variables

- `$HOSTNAME` - Computer name
- `$LANG` - Language setting
- `$EDITOR` - Default editor
- `$PS1` - Prompt string

# The PATH Variable

## What is PATH?

A colon-separated list of directories where the shell looks for commands.

```
1  echo $PATH
2  # /usr/local/bin:/usr/bin:/bin:/usr/sbin:/sbin
```

## How it works

When you type `ls`, the shell searches directories in PATH order until found.

## Modifying PATH

```
1  # Add directory to PATH (at end)
2  export PATH=$PATH:/home/user/bin
3
4  # Add to beginning (higher priority)
5  export PATH=/home/user/bin:$PATH
```

# File Permissions Preview

```
1 $ ls -l myfile.txt
2 -rw-r--r-- 1 user group 1234 Jan 28 10:00 myfile.txt
```

## Permission Breakdown

```
1 -  rw-  r--  r--
2 |
3 |   Others: read only
4 |   Group: read only
5 |   Owner: read + write
6 |   File type (- = regular file)
```



**Note:** We'll dive deep into permissions in Week 2!

# Lab 1 Preview: VM Setup

What you'll do:

1. 🖥️ **Install VirtualBox/VMware** on your laptop
2. 📄 **Download Linux distribution** (Ubuntu Server recommended)
3. ⚙️ **Create and configure VM** (minimum specs provided)
4. 🚀 **First boot and initial setup**
5. 🐚 **Practice shell navigation commands**

Deliverables:

- Screenshot of successful VM boot
- Output of basic commands ( `pwd` , `ls` , `whoami` )
- Create a directory structure using `mkdir`

**Time Estimate:** 2 hours

✅ **Goal:** Have a working Linux environment ready for Week 2!

# Tips for Success

## Learning Strategies

- 📖 Read error messages carefully
- 🔍 Use `man` pages before Googling
- 💻 Practice daily, even 15 minutes
- 🎯 Type commands, don't copy-paste
- 📝 Keep a command journal
- 🤝 Form study groups

## Common Pitfalls



- ❌ Ignoring case sensitivity
- ❌ Forgetting `sudo` when needed
- ❌ Not reading documentation
- ❌ Running `rm -rf` carelessly
- ❌ Hardcoding values in scripts
- ❌ Not testing before submission

🎓 **Remember:** The goal isn't memorization—it's understanding how the system works!




# Automated Grading System


## How It Works

- All assignments submitted via **GitHub**
- **GitHub Actions** runs automated tests
- Tests use **dynamic inputs** (no hardcoding!)
- You'll see results instantly:  or 

## Grading Philosophy

- 1  Green Checkmark = Full Points
- 2  Red Cross = Zero Points (but you can resubmit!)

**Key Rule:** Code must work on the grading environment, not just "on your machine"

 **Anti-Cheat:** Midterm flags are cryptographically tied to YOUR GitHub username!

# Important Dates & Deadlines

## Homework Deadlines

- **Homework 1:** Week 3
- **Homework 2:** Week 6
- **Homework 3:** Week 11
- **Homework 4:** Week 14

## Quizzes

- **Quiz 1:** Week 7
- **Quiz 2:** Week 12

## Major Assessments

- **Midterm Exam:** Week 8
  - "Broken VM" Challenge
  - 4 hours
  - 20% of grade
- **Capstone Project:** Week 15
  - Infrastructure deployment
  - Defense presentation
  - 40% of grade



**No Extensions:** Late work not accepted. Plan accordingly!

# Resources & Support



## Course Materials

- **LMS:** All lectures, labs, and assignments
- **GitHub Org:** Starter code and submissions
- **Discussion Forum:** Ask questions, help peers



## Getting Help

1. **Office Hours:** TBD (to be announced)
2. **Lab Sessions:** Hands-on assistance during lab time
3. **Discussion Forum:** Community support
4. **Documentation:** Man pages, official docs



## Useful Links

- Course GitHub: `github.com/your-org/css262`
- Linux docs: `linux.die.net`
- Bash guide: `mywiki.woledge.org/BashGuide`

# Week 1 Action Items

## ✓ Before Next Lecture:

1. Read **Chapter 1-3** of "The Linux Command Line"
2. Set up **GitHub account** (if you don't have one)
3. Join course **GitHub Organization** (link on LMS)
4. Review VM requirements (8GB RAM minimum)

## ✓ For Lab This Week:

1. Install **VirtualBox** or VMware
2. Download **Ubuntu Server ISO** (link provided)
3. Bring laptop with **at least 20GB free space**
4. Complete **Lab 1: VM Setup & Shell Navigation**



## Optional:

- Explore `man` pages for basic commands
- Try shell navigation on your own

# Questions?



**Remember:** There are no stupid questions!

The shell can be intimidating at first, but you'll be comfortable in no time.

**Next Week:** Users, Groups & Permissions  

Thank You!



**See you in the lab!**

Start your Linux journey today 🚀

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