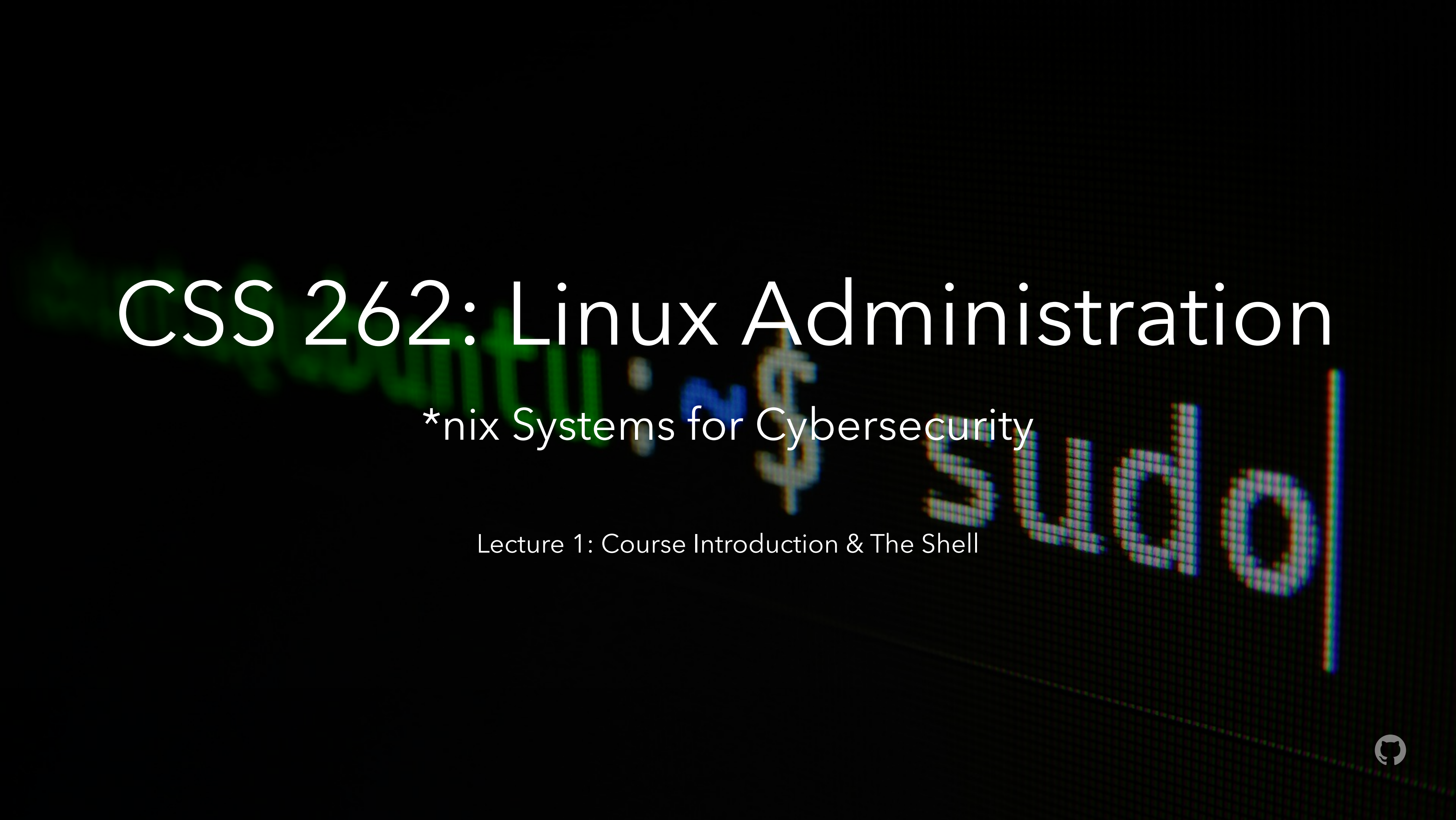


CSS 262: Linux Administration

*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

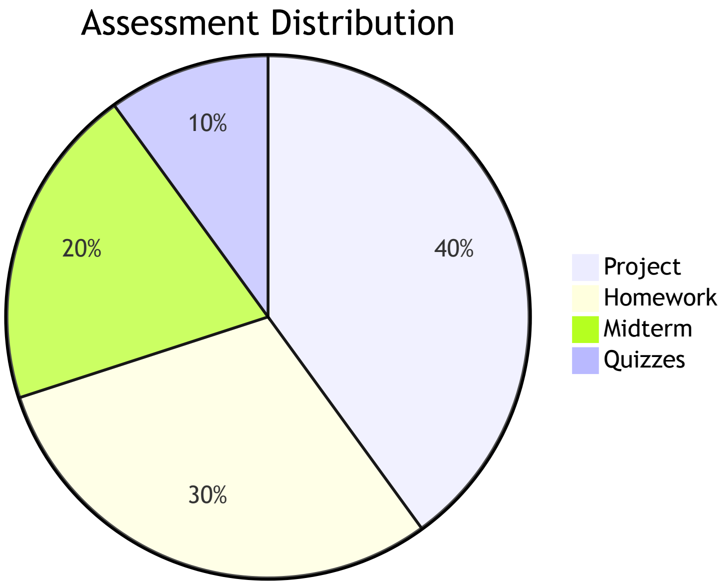
Course Code: CSS 262
Duration: 15 Weeks
Credits: 5-6 ECTS
Level: Undergraduate

🎯 Workload

- Lectures: 15 hours
- Labs: 30 hours
- Self-study: 45 hours
- Assignments: 16 hours
- Exams & Project: 32 hours

Total: ~138 Hours

📈 Grading Breakdown



- ✅ **Automated Grading** via GitHub Actions
- 🔄 Resubmissions allowed until deadline
- 🎯 Code must work on standard environment

🎯 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
- **dash** - Debian Almquist Shell

In this course: We'll focus on **bash** (default on most Linux distributions)

Check Your Shell

```
# See current shell
echo $SHELL

# List available shells
cat /etc/shells

# Change shell
chsh -s /bin/bash
```

Shell vs Terminal

- **Terminal:** The window/application
- **Shell:** The program running inside
- Think: Terminal = TV, Shell = Channel

The Command Prompt

```
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

```
# Print working directory
pwd

# List contents
ls
ls -l    # Long format
ls -a    # Show hidden files
ls -lah  # All options combined

# Change directory
cd /etc
cd ~     # Go home
cd ..    # Go up one level
cd -     # Go to previous directory
```

File Operations

```
# Create file
touch file.txt

# Copy files
cp source.txt dest.txt

# Move/rename
mv old.txt new.txt

# Delete
rm file.txt
rm -r directory/  # Recursive

# Create directory
mkdir new_folder
mkdir -p path/to/folder  # Parents
```

Getting Help

1. Manual Pages (man)

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

2. Command Help

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

3. Type and Which

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

4. Info Pages

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

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

File System Hierarchy

```
/                     Root directory
├── bin/            Essential user binaries
├── boot/           Boot loader files
├── dev/            Device files
├── etc/            System configuration
├── home/           User home directories
├── root/           Root user's home
├── tmp/            Temporary files
├── usr/            User programs
│   ├── bin/        User binaries
│   └── local/      Locally installed
└── var/            Variable data (logs, etc.)
```

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

Command Structure & Syntax

Basic Anatomy

```
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

```
ls -l /home/user              # List in long format
cp -r source/ destination/    # Copy recursively
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

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

Text Search

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

Pipes and Redirection

Redirection Operators

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

Pipes (|)

```
ls -l | grep ".txt"                    # List only .txt files
cat /var/log/syslog | grep error | less  # Chain commands
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

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

Examples

```
ls *.txt              # All .txt files
ls file?.txt          # file1.txt, fileA.txt, etc.
ls [a-c]*             # Files starting with a, b, or c
rm *~                 # Delete backup files
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.

```
# View variables
env                  # View all
echo $HOME           # View specific

# Set variable
MY_VAR="Hello"
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.

```
echo $PATH
# /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

```
# Add directory to PATH (at end)
export PATH=$PATH:/home/user/bin

# Add to beginning (higher priority)
export PATH=/home/user/bin:$PATH
```

File Permissions Preview

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

Permission Breakdown

```
-  rw-  r--  r--
│  │    │    │
│  │    │    └─ Others: read only
│  │    └────── Group: read only
│  └─────────── Owner: read + write
└────────────── 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

```
✅ Green Checkmark = Full Points
❌ 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.wooledge.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 🚀

CSS 262 - Linux Administration & *nix Systems for Cybersecurity