



Operating Systems Lab

CSCE 000/3402

Lecture 0: Lab Introduction

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Welcome



Dr. Karim Sobh

Office Hours: by appointment over Zoom

Lectures:

SEC-01 08:30 – 11:20 T (Online over Zoom)

SEC-02 14:30 – 17:20 T (Online over Zoom)

SEC-03 17:30 – 20:20 T (Online over Zoom)

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Hadeer El Sadawy

Office Hours: (Over Zoom)

Tuesday During the Lab Times

Or by appointment.

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Office: 2138 SSE

Course Home page Material, Assignments , Grading, and Discussion are all on Blackboard.



This is a Very Challenging Lab

- Start from Scratch.
- Build the needed skills incrementally.
- Intensive kernel hacking exercises.
- Limited debugging facilities.
- Intensive need for research and looking for information.
- Back-2-Back exercises.
- Limited consolidated documentation, and decentralized scattered information.



Catalog Description

Fundamentals of systems programming, standard administration tools, shell programming, Make utility, file I/O, access rights for files and directories, system data files and information, system configuration, Unix processes, process control, synchronization, signals, daemons, interprocess communication, kernel adaptation and generation.



Prerequisites

- **CSCE 231/2303:** Computer Organization and Assembly Language Programming.
- Need to be take concurrently with **CSCE 345/3402-Operating Systems.**
- **Advice:**
 - Get your hands dirty with the UNIX shell, Makefiles, VI, SSH, terminals, and the GCC compiler options and switches.
 - Install the **Latest Linux Debian** distribution in a VM using VirtualBox. Do not install the Desktop GUI environment (based on xlib) ; we will provide you with a preconfigured appliance image but it might be a good idea to build one on your own.



Course Outcomes

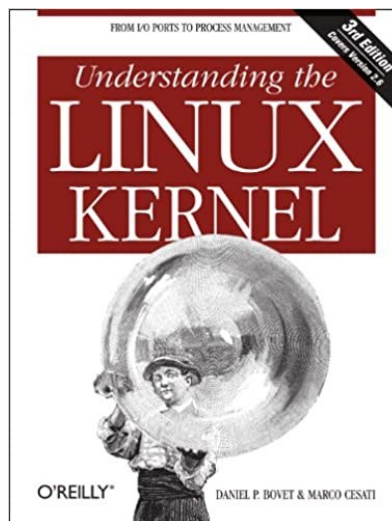
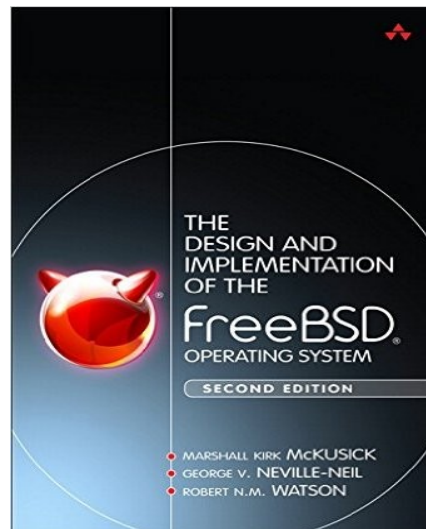
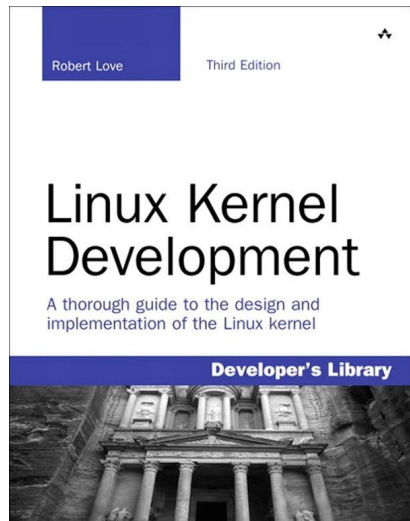
During the course, you will learn:

- How to write shell scripts.
- How to build a simple shell; fork, exec family, pipes, redirection, etc.
- How to amend and recompile the kernel.
- How to write kernel modules.
- How to intercept systems call; main mechanism behind **rootkits**.
- Different binary types and their different uses.
- Details about the Linux VFS implementation.
- How to extend the proc file system.
- How to extend device abstractions.
- Deploying crypto-systems within the kernel.
- In-depth scheduling, run queues, idle queues, and different process states and transitions within a process life cycle.



Textbooks and References

- The CSCE-3401 book is your main reference for all Operating Systems concepts that you will need in the Lab.
- Additionally, the following references might be helpful:
 - Robert Love, **Linux Kernel Development** (3rd Edition). Addison-Wesley Professional; (22 Jun. 2010).
 - Marshall Kirk McKusick, George V. Neville-Neil, and Robert N.M. Watson. 2014. **The Design and Implementation of the FreeBSD Operating System** (2nd Edition). Upper Saddle River, NJ : Addison-Wesley, 2015. - 886 p.
 - Daniel Pierre Bovet, Marco Cesati. **Understanding the Linux Kernel** (3rd Edition). O'reilly.



Tools

- **All the tools are freely available:**
 - VirtualBox.
 - GNU GCC compiler and linker.
 - The Kernel Source code.
 - Module Management Utilities: modutils.
 - Unix utility programs, e.g. sed, awk, tail, head, etc.
 - And more ...



Course Mode

- The course will be conducted online.
- We will meet during the lab time and will spend 30-60 minutes to explain important material that you essentially need to be able to perform the lab exercise.
- You will receive a document that describe what you are required to do in the lab exercise.
- You need to work on the lab exercise on your own and you can reach out to the TA or the Doctor if you face problems or need more explanation.
- You need to submit your work on BlackBoard and arrange a Demo with the TA. Each lab exercise will be worth a fraction of the overall course grade; **you will not get a grade without the demo.**
- Lectures will be conducted over zoom to go over important material and answer student questions.
- Office hours will be over zoom and by appointment.
- All Zoom lectures, labs, and meetings will be records.
- When you send an email please include your student ID and the course name/number in the subject as well as the email body. I might not look at emails with empty subjects or they might be forwarded to the junk folder.
- I will respond to your email in a duration from 0 to 48 hours.
- You can also reach me on the Google Hangout course chat group.
- **VERY IMPORTANT:** the lab course syllabus is subject to changes if the university administration decided to switch to face-2-face mode of teaching; you will be provided with an updated syllabus in that case.



Tentative Schedule

| Week | From | To | Lecture (Tuesday) | Lab Exercises |
|------|-------|-------|--|---|
| 1 | 31/01 | 04/02 | Lab Introduction Fundamentals and Shell Scripting | Shell Scripting (Out) |
| 2 | 07/02 | 11/02 | What is a Shell? | Shell Scripting (In) Simple Shell (Out) |
| 3 | 14/02 | 18/02 | | |
| 4 | 21/02 | 25/02 | What is a Kernel Module? | Simple Shell (In) Simple Kernel Module (Out) |
| 5 | 28/03 | 04/03 | Brief Intro about VFS File I/O within the Kernel | Simple Kernel Module (In) Version Kernel Module (Out) |
| 6 | 07/03 | 11/03 | System Calls Table Binary Types | Version Kernel Module (In) System Calls Table Kernel Module (Out) |
| 7 | 14/03 | 18/03 | Page Tables and Protection Bits Intercepting System Calls | System Calls Table Kernel Module (In) Intercepting the Fork System Calls (Out) |
| 8 | 21/03 | 25/03 | | Intercepting the Fork System Calls (In) Enabling KALSR (Out) |
| 9 | 28/03 | 01/04 | More about VFS. What is a Proc File System? | Enabling KALSR (In) Proc File System Integration (Out) |
| 10 | 04/04 | 08/04 | Character Devices | Proc File System Integration (In) Crypto Character Devices (Out) |
| 11 | 11/04 | 15/04 | | |
| 12 | 18/04 | 22/04 | FreeBSD ULE Scheduler Case Study | Crypto Character Devices (In) Redundant Fork (Out) |
| 15 | 25/04 | 29/04 | Holiday | |
| 16 | 02/05 | 06/05 | | |
| 17 | 09/05 | 13/05 | | Redundant Fork (In) |
| 18 | 16/05 | 20/05 | | |



Grading

- Final grades are broken down as follows:
 - Exercise : 100%
- **Estimate** grade ranges:
 - A: 89-100%
 - B: 79-89%
 - C: 69-79%
 - D: 60-69%
 - F: below 60%



Grading

- The course overall grade is divided over the lab exercises.
- You need to score over 60% to be able to pass the Lab.



Exams

- There will be no exams, only lab exercise.
- You have to submit the lab exercise on time.
- Late lab exercise will not be accepted and you will definitely lose their corresponding portion of the grade.



Lab Exercises

- A set of lab exercises (8 to 10) covering topics discussed in the lab lectures.
- Most of the lab exercises need to be implemented in the C language unless stated otherwise in the lab exercise handout; first assignment will use the bash scripting language.
- Some assembly might be needed; will be indicated in the lab exercise handout.
- Details about each lab exercise grade, due date, and details will be included with the lab exercise handout.
- All lab exercises need to be submitted online to Blackboard.
- You need to arrange for a demo with the TA to show, present and discuss your work; **no demo no grade.**
- **Lab exercises will not be accepted after the deadline; and hence a late submission will receive a ZERO grade.**



Tentative Lab Exercises Grade Breakdown

- In this lab, lab exercises are worth 100% of your grade and are broken down tentatively as follows:
 - Bash Shell Scripting → 5%.
 - Simple Shell → 10%.
 - Simple Kernel Module → 5%.
 - Version Kernel Module → 10%.
 - System Calls Table Kernel Module → 5%.
 - Intercepting the Fork System Calls → 10%.
 - Enabling KALSR → 5%.
 - Proc File System Integration → 10%.
 - Crypto Character Devices → 20%.
 - Redundant Fork → 20%.



Attendance

- Zoom keeps a record of who attended and the start and end time of each student.
- I will ask random questions to random students during the lab lecture and if you are busy doing something else during the lecture that resulted in delayed response you will be considered absent.
- **Failing to attend** at least **80%** of the course will result in **failing** the course.
- You have up to **3 absences** after which you will:
 - Receive an **F grade** if all 3 absences are before drop date.
 - Else, you will be given the choice to get an F or lose one letter grade for each absence beyond the 3.
- You do not have to use the 3 allowed absences as those are for emergencies and avoiding them is highly encouraged.
- It is always better for you to make sure that you are ready at the Zoom meeting 5 minutes before the lab lecture begins.
- Missing the first 10 minutes of the lab lecture will make it very difficult for you to follow up.
- **Note: some of the above are subject to change and amendments are possible if we return back to face-2-face mode of transactions.**



Getting Help and Key to Success

- Attend lab lectures and do the lab exercises on time.
- **Take notes.**
- Participate in class.
- Use Blackboard for discussions with your colleges.
- Utilize Lab staff office hours:
 - You are more than welcome to visit me in my office hours to ask question; please make sure to arrange a Zoom appointment with me or the TA.
 - Replaying the whole lab lecture is not an option; it means that you did not attend or you were doing something else.
 - **“I did not understand the whole lab lecture”** does not make any sense to me; basically you should have stopped me in the lecture and asked.
 - I expect that you **do some minimal study effort** before you seek help.
 - Ask specific questions by email to course staff.
- The Lab **pace** is really **challenging** and needs a good runner.
- Do not postpone the work; as soon as you get the lab exercise start working on it right away.



Academic Honesty

- Academic Honesty is a very important aspect in academic life.
- Plagiarism and/or cheating is not accepted at all.
- Any attempt of misconduct will result in failing the course.
- Academic misconduct policy will apply on you firmly if caught cheating.
- Both the transmitter and the receiver are hold equally accountable.
- Always mention your sources.
- There will be no flexibility.
- We will not grade your assignments before you download the honesty agreement from blackboard, and submit a signed copy to me or the TA in person.
- so **BOTTOM LINE: DO NOT EVER CHEAT.**



Classroom and Lecture Rules

- It is totally prohibited to use your mobile during the lecture ; ***what I mean by using your phone is talking on the phone, messaging, phone ringing, beeping, and even holding it in your hand or putting it in front of you on your desk.***
- Leaving early will be considered a missed lecture.
- If you come to the class late you do not have the right to ask questions.
- **You will need to attend at least 80% of the lectures or else you might fail the course.**
- **Note: some of the above is subject to change and amendments are possible if we return back to face-2-face mode of transactions.**



More Information

- For more details please download the Syllabus PDF of the course off blackboard and read it thoroughly.
- The syllabus is your main source of information.
- The rules that govern this course are stated in both the Syllabus and this slide set; **anything stated in the Syllabus and/or here will be considered and applied.**

