CS-GY 6233: Introduction to Operating Systems

New York University Tandon School of Engineering

Department of Computer Science and Engineering

Fall 2023

Professor Kamen Yotov (ky12@nyu.edu)

Thursday, 6:00 PM to 8:30 PM, 2 Metrotech, Room 911

Professor office hours after lecture or by appointment

Course Pre-requisites:

Graduate Standing.

Course Description:

This is a graduate-level course that covers an introduction to operating systems. It is geared at graduate students who have not had a good undergraduate course that covers the principles of operating systems. This material is critical for understanding anything about what is really going on in your desktop, your laptop, your phone and/or in your data center.

While it covers material that often finds its place in undergraduate curricula, we will be supplementing that material with some more recent results from the systems literature, and we will be doing a lot of hands-on homework to see what a real operating system looks like.

In addition, there is the opportunity to customize the material based on overall student background entering the course. Finally, we will also focus on some very recent commercial trends in the Operating Systems space, with particular focus on virtualization and how it is transforming the way we think about computing and the way that every Fortune-1000 company manages its information technology infrastructure.

Course Objectives:

- The Course illustrates modern operating systems design and implementation.
- Students will be able to study low-level internals of operating systems and:
- Understand x86 Hardware and Assembly Language and how it is used to implement the core concepts of Operating Systems.

- Understand Process Management and be able to design, implement, and evaluate various scheduling algorithms for multiprocessing and multi-threaded systems.
- Understand Memory Management and be able to design, implement, and evaluate different segmented and virtual memory solutions.
- Understand I/O subsystem to compare different solutions (PIO, Interrupts, DMA)
- Understand the foundations of Security and how it is implemented in the kernel of modern operating systems.
- Students will also be exposed to modern Virtualization and Containerization methods and will be able to compare their application in scalable infrastructure.

Readings:

Textbooks:

- Modern Operating Systems, by Andrew S. Tanenbaum. (Available at NYU Bookstore.)
- xv6: A simple, Unix-like teaching operating system, by Russ Cox, Frans Kaashoek, and Robert Morris. - [available here]

Useful References:

Linux Command Line Cheat Sheet

GDB Cheat Sheet

Grade Calculation:

15% Unit Quizzes

50% Homework (Programming Projects)

35% Final Project

Course requirements:

- Attendance will not be taken, but it is highly recommended.
- Assignments must be received by midnight on the day they are due.
- Late homework will not be accepted.

Course Schedule:

In the following, MOS stands for “Modern Operating Systems” and xv6 stands for “xv6: A simple, Unix-like teaching operating system”. All lecture content will be posted on Brightspace.

Unit 1 (MOS 1; xv6 0-1)

1. (Quick) Computer History
2. What is an Operating System?
3. Hardware Review
4. Operating Systems Concepts

Unit 2 (MOS 1; xv6 0-1)

1. C Refresher

Unit 3 (MOS 1; xv6 0-1, Appendix B)

2. PC Architecture
3. Assembly
4. xv6 Boot Process

Unit 4 (MOS 2; xv6 3)

1. System Calls
2. Processes

Unit 5 (MOS 2, 3.1-3.2; xv6 5)

1. Scheduling
2. Threads
3. Memory Management

Unit 6 (MOS 3.3-3.5; xv6 2)

- Virtual Memory

Unit 7 (MOS 5; xv6 3)

- I/O

Unit 8 (MOS 2.3, 2.5, 6; xv6 4)

- Concurrency

Unit 9 (MOS 2.3, 2.5, 6; xv6 4)

- Deadlock

Unit 10 (MOS 4.1-4.4; xv6 6)

- File Systems

Unit 11 (MOS 7, 8.3)

- Virtualization

Unit 12 (MOS 9)

- Security

Moses Center Statement of Disability

If you are a student with a disability who is requesting accommodation, please contact New York University's Moses Center for Students with Disabilities (CSD) at 212-998-4980 or mosescsd@nyu.edu. You must be registered with CSD to receive accommodation. Information about the Moses Center can be found at www.nyu.edu/csd. The Moses Center is located at 726 Broadway on the 3rd floor.

NYU School of Engineering Policies and Procedures on Academic Misconduct – complete Student Code of Conduct here

1. Introduction: The School of Engineering encourages academic excellence in an environment that promotes honesty, integrity, and fairness, and students at the School of Engineering are expected to exhibit those qualities in their academic work. It is through the process of submitting their own work and receiving honest feedback on that work that students may progress academically. Any act of academic dishonesty is seen as an attack upon the school and will not be tolerated. Furthermore, those who breach the school's rules on academic integrity will be sanctioned under this Policy. Students are responsible for familiarizing themselves with the School's Policy on Academic Misconduct.

2. Definition: Academic dishonesty may include misrepresentation, deception, dishonesty, or any act of falsification committed by a student to influence a grade or other academic evaluation. Academic dishonesty also includes intentionally damaging the academic work of others or assisting other students in acts of dishonesty. Common examples of academically dishonest behavior include, but are not limited to, the following:

3. Cheating: intentionally using or attempting to use unauthorized notes, books, electronic media, or electronic communications in an exam; talking with fellow students or looking at another person's work during an exam; submitting work prepared in advance for an in-class examination; having someone take an exam for you or taking an exam for someone else; violating other rules governing the administration of examinations.

4. Fabrication: including but not limited to, falsifying experimental data and/or citations.

5. Plagiarism: intentionally or knowingly representing the words or ideas of another as one's own in any academic exercise; failure to attribute direct quotations, paraphrases, or borrowed facts or information.

6. Unauthorized collaboration: working together on work meant to be done individually.

7. Duplicating work: presenting for grading the same work for more than one project or in more than one class, unless express and prior permission has been received from the course instructor(s) or research adviser involved.

8. Forgery: altering any academic document, including, but not limited to, academic records, admissions materials, or medical excuses.

NYU School of Engineering Policies and Procedures on Excused Absences – complete policy here

1. An absence can be excused if you have missed no more than 10 days of school. If an illness or special circumstance has caused you to miss more than two weeks of school, please refer to the section labeled Medical Leave of Absence.

2. Students may request special accommodations for an absence to be excused in the following cases:

- Medical reasons
- Death in immediate family
- Personal qualified emergencies (documentation must be provided)
- Religious Expression or Practice

Deanna Rayment, deanna.rayment@nyu.edu, is the Coordinator of Student Advocacy, Compliance and Student Affairs and handles excused absences. She is located in 5 MTC, LC240C and can assist you should it become necessary.

NYU School of Engineering Academic Calendar – Click Here

Please pay attention to notable dates such as Add/Drop, Withdrawal, etc. For confirmation of dates or further information, please contact Susana: sgarcia@nyu.edu