

# CPS 310 – Operating Systems

## Fall 2023

(Last Modified: November 1, 2023)

## 1 General

### Course

Lecture	Mon/Wed 3:05-4:20pm
Discussion	Fri 3:05-4:20pm
Location	LSRC B101

### Instructors

Name	Matthew Lentz
Email	<a href="mailto:mlentz@cs.duke.edu">mlentz@cs.duke.edu</a>
Website	<a href="https://www.cs.duke.edu/~mlentz">https://www.cs.duke.edu/~mlentz</a>
Office Hours	Tuesday 3-4pm (LSRC D314) + After Lecture

### Graduate TAs

Avery Blanchard [avery.blanchard@duke.edu](mailto:avery.blanchard@duke.edu) (Monday 12-1pm (LSRC D309))  
Swati Singh [swati.singh@duke.edu](mailto:swati.singh@duke.edu) (Friday 2-3pm (Zoom))

### Undergraduate TAs

Chavez Cheong (Thursday 7-8pm (Zoom))  
Erik Dahlberg (Monday 5-7pm (Zoom))  
Alexander Du (Friday 4:30-5:30pm (Zoom))  
Andrew Fate-Bolognone (Tuesday 1-2pm (LSRC D309))  
Claire Hagan (Thursday 2-3pm (Zoom))  
Julia Kourelakos (Friday 10-11am (LSRC D309))  
Mark Liu (Wednesday 1-2pm (Zoom))  
Helen Xu (Monday 7-8pm (Zoom))  
Ethan Yu (Friday 1:30-2:30pm (LSRC D122))

### Resources

Website	<a href="https://courses.cs.duke.edu/fall123/compsci310/">https://courses.cs.duke.edu/fall123/compsci310/</a>
Sakai	<a href="https://sakai.duke.edu/portal/site/d74f2135-c72a-496f-9838-4fe4955165fe">https://sakai.duke.edu/portal/site/d74f2135-c72a-496f-9838-4fe4955165fe</a>
Gradescope	<a href="https://www.gradescope.com/courses/534430">https://www.gradescope.com/courses/534430</a>
Ed	<a href="https://edstem.org/us/courses/39375/">https://edstem.org/us/courses/39375/</a>

## 2 Overview

This course will focus on fundamental principles of operating systems. We will explore the various roles of the operating system which include managing and multiplexing available hardware resources, providing higher-level abstractions for applications to use in interacting with the hardware platform, and enforcing isolation and protection for software programs. We will cover topics such as: concurrency, file systems, synchronization, storage, virtualization, communication, security/protection, and scheduling. Additionally, we will explore how these concepts relate to modern systems beyond the operating system itself (e.g., distributed systems).

## 3 Expectations

### 3.1 Preconditions

The prerequisite for this course is either: 1) you are a graduate student in CS or ECE, or 2) you have completed CPS 210 (Introduction to Computer Systems) or ECE/CPS 250 (Computer Architecture). Therefore, we expect that you already understand the basics of computer architecture, and that you have experience in implementing programming projects in C.

If you feel that you could use a refresher on computer architecture, please refer to “Welcome to the Machine” by Jeff Chase <https://users.cs.duke.edu/~chase/systems/arch-overview.pdf>.

### 3.2 Postconditions

After completing this course, we expect you to be able to:

1. Understand the fundamentals of operating systems, including: concurrency, communication, protection, isolation, architecture, storage, and scheduling
2. Implement common primitives (e.g., threads) in a simple operating system (i.e., xv6 from MIT) while writing programs that use these primitives on a real-world operating system (i.e., Linux)
3. Understand various factors that impact performance and resource efficiency as a result of hardware and software running underneath your programs (e.g., virtual memory)
4. Understand how operating systems concepts relate to broader systems (e.g., distributed systems), and how recent challenges/advances are shaping the design and implementation of modern operating systems (e.g., trusted hardware, high-speed I/O)

## 4 Resources

**Textbooks** We will be using the OSTEP textbook for this course. For each lecture in the schedule, there will be corresponding readings in the OSTEP book. This is a free, open-source textbook that is available online at the link below:

1. **Operating Systems in Three Easy Pieces (OSTEP)**  
<https://pages.cs.wisc.edu/~remzi/OSTEP/>

Other resources will be provided to you throughout the semester. If you wish to read through additional perspectives on the course content, you may want to reference one (or both) of the following textbooks:

1. **Operating Systems: Principles and Practice**  
<https://ospp.cs.washington.edu/index.html>  
(Alternative to the above textbook)
2. **xv6: a simple, Unix-like teaching operating system**  
<https://pdos.csail.mit.edu/6.S081/2021/xv6/book-riscv-rev2.pdf>  
(May be useful to refer to for labs/projects)

**Sakai** We will be using Sakai as a general course platform, to report grades, issue quizzes, and to (occasionally) make course announcements.

**Gradescope** We will be using Gradescope for submitting and automatically grading labs. We will also use it for grading exams.

**Ed** We will be using Ed to serve as a discussion forum for the course and the primary place for making course announcements.

**Assistance** We want to help you and we encourage you to visit office hours and/or ask questions on Ed as needed. Please be respectful of staff time: start early, seek help early, and do not expect extra time beyond the posted schedule. We expect you to make a good faith effort to solve problems yourself before seeking help; additionally, when asking for help, please explain your thought process and what you have tried so far so that we can better help you. Keep up with the Ed board and check to see if your question is already answered. If a TA refuses to help you, please respect their decision and raise the issue with the instructors if you feel you are treated unfairly.

## 5 Grading

Your final grade in the course will be determined by the following percentage allocations:

Type	%	Description
Exams	45	Midterm exam (18) and final exam (27)
Labs	50	User- and kernel-space programming assignments
Participation	5	Actively engaging with in-class and online discussions

Note that attendance is not mandatory; however, we strongly encourage it because there will be a number of interactive elements throughout the course. You are responsible for all material covered and assignments given out during any class that you miss.

### 5.1 Exams

There will be one midterm exam and one final exam. The midterm exam will be given in-class on October 11th. The final exam is scheduled for December 13th from 2-5pm in LSRC B101. Each exam is cumulative, covering all content from the start of the course up to the exam; however, for the midterm exam, content covered by the class immediately prior to the exam is out of scope. For both exams, you may create and make use of a single page of notes (two-sided), which may be hand-written or typed. With the exception of this page of notes, the exam is closed book and closed notes.

### 5.2 Labs

There will be eight programming lab assignments that are meant to be completed individually. You can find more information on the labs here: <https://courses.cs.duke.edu/fall23/compsci310/assignments.html>.

### 5.3 Participation

The goal is to encourage you to participate in the class in some manner. For some, that may involve engaging with in-class discussions. For others, that may involve the creating, answering, or commenting on Ed forum posts.

### 5.4 Late Policy

We expect you to turn in your work by the day and time it is due. Note that if a time is not listed, you should assume the deadline is 11:59pm ET on the day listed. However, we have the following late policy for labs and projects:

- (0, 24] hours late: 10% penalty
- (24, 48] hours late: 20% penalty
- (48,  $\infty$ ) hours late: No Credit

Exceptions to this late policy are allowed only for Dean's excuses and short term illnesses as indicated by submitting the Short-term Illness Notification Form, which you can find here: <https://trinity.duke.edu/undergraduate/academic-policies/class-attendance-and-missed-work>.

## 5.5 Regrading Policy

All regrading requests (labs, projects, quizzes, exams) must be submitted within one week of the graded item being returned/available. Please use the regrade request functionality available on Gradescope to issue your request. Requests after one week will be denied.

## 6 Academic Integrity

We expect everyone to uphold the Duke Community Standard, which you can find here: <https://studentaffairs.duke.edu/conduct/about-us/duke-community-standard>. In particular, this standard is comprised of:

- I will not lie, cheat, or steal in my academic endeavors
- I will conduct myself honorably in all my endeavors
- I will act if the Standard is compromised

Please ask me if you are unsure which actions may (or may not) violate the community standard as part of this course. However, you can find specific collaboration guidelines for different types of coursework below.

### 6.1 Collaboration Guidelines

**Labs** You are more than welcome to discuss the labs with your fellow classmates. This includes discussing the specification, proposed approaches to solving the lab, working through high-level designs on a whiteboard, or asking questions on the forums. However, each of you is responsible for writing up your own implementation for the lab. Do *not* share code, either snippets or solutions as a whole, with one another; this also extends to the forums, unless there is explicit approval from the instructor or one of the TAs. Do not incorporate code you find on the Internet (or from paper archives), from students who took the class previous semesters, or other sources. The line should be quite clear here, but please reach out if you have any questions regarding this policy.

## 7 Students with Disabilities

Duke University is committed to providing equal access to students with documented disabilities. Students with disabilities may contact the Student Disability Access Office (SDAO) to ensure your access to this course and to the program. There you can engage in a confidential conversation about the process for requesting reasonable accommodations both in the classroom and in clinical settings. Students are encouraged to register with the SDAO as soon as they begin the program. Please note that accommodations are not provided retroactively. More information can be found online at [access.duke.edu](https://access.duke.edu) or by contacting SDAO at 919-668-1267, [SDAO@duke.edu](mailto:SDAO@duke.edu).

## 8 Environment

Interactive discussions are one of the key components that make this type of course useful, especially when we dive into more advanced topics. I want everyone to make sure that they do their best to foster an inclusive environment, since that will enable us to have the richest discussions. In general, please treat teaching staff and other students with kindness and respect both in class and outside of class (e.g., Ed forums). We will disable anonymous posting if we see any threatening or disruptive posts. If you feel uncomfortable for any reason, please let me know.

Let us know if you have concerns we can address regarding your safety or health. Please know that we are concerned for you. We understand that you may be facing negative reactions to stress and pressure, other personal challenges, or just the burdens of managing your life and future. Be mindful of your needs for sleep, exercise, proper food, recreation, social connection, and constructive engagement with your problems. We encourage you to take advantage of Duke resources for wellness and mental health. Ask for help when you need it.

## 9 Course Evaluations

Please take a moment of your time at the end of the semester to submit a course evaluation. These evaluations are incredibly useful to both us personally as well as to the department as a whole. You can provide your feedback at the following link: <http://duke.evaluationkit.com/>. Note that if you have suggestions for how we improve the course, feel free to reach out at any time.

## 10 Modifications

We tried to make this syllabus both correct and complete; however, we reserve the right to modify the contents of the syllabus while the course is underway. We will make sure that any modifications are clearly communicated to you with sufficient advance notice.