Computer Systems CS 5600

Graduate Course, Khoury College of Computer Sciences
Northeastern University, Vancouver Campus
Fall 2022 Semester

We acknowledge that the land on which we gather is the unceded territory of the Coast Salish Peoples, including the territories of the xʷməθkʷəy̓əm (Musqueam), Sḵwx̱wú7mesh (Squamish), and səlilwətał (Tsleil-Waututh) Nations.

Class Hours: Thursday 10:00am-12:00pm (Pacific time)

Class Location: Northeastern Vancouver Campus (Room 1418)

Instructors: Yvonne Coady (m.coady@northeastern.edu)

Teaching Assistants   Zijian Cao (cao.zi@northeastern.edu)

Textbooks   The textbook for this course is free and online!
                        Operating Systems: Three Easy Pieces
                        Remzi H. Arpaci-Dusseau and Andrea C. Arpaci-Dusseau
                        Arpaci-Dusseau Books
                        Operating Systems, Three Easy Pieces

Studies the structure, components, design, implementation, and internal operation of computer systems, focusing mainly on the operating system level. Covers current operating system components and construction techniques system calls, I/O, memory management, and file system structures. Discusses issues arising from concurrency and distribution, such as scheduling of concurrent processes, inter-process communication and synchronization, resource sharing and allocation, and deadlock management and resolution. Includes examples from real operating systems. Exposes students to the system concepts through programming exercises. Requires admission to MS program or completion of all transition courses.
This course will explore operating system implementation through programming assignments. This is a programming heavy course; students are expected to be proficient at programming.

NOTE: in addition to our class time every Thursday (10:00am-12:00pm), where we will be getting a good workout in team based exercises, all students are expected to view all videos and references before class, and participate in "mock interviews" with your TA. You should allocate a minimum of 20-25 hours a week for this course!

Course Objectives and Prerequisites

By the end of this course, you will be ready to:

- Build and use tools for inspecting and debugging programs at a low level
- Be comfortable with concepts like concurrency and parallelism
- Better understand operating systems
- Get some experience working on a large scale codebase
- Position yourself for jobs as a systems programmer

Prerequisites

- You should have a working knowledge of C/C++, and be ready to learn new languages
- You should have experience working on the terminal in a Unix environment
- You should be comfortable using a text editor or IDE of your choice
- You should be willing to work with others, share your thoughts, and ask questions

Additional Course Prerequisites

- It is possible you have not taken a course at Northeastern.
    - This course builds on an assumed skillset, such as the bridge course 5008.
    - This means, you will have to work hard. We will all support each other in learning some C/Assembly, and early lectures will be a refresher.
    - You will need to be willing to work hard in this course. Do not skip assignments or procrastinate!
- You should have basic knowledge in github, using any editor, and know how to compile, run, and debug programs.

Course Overview

Our course will broadly include

- Computer Architecture and Assembly
- Virtualization
    - Processes, Threads and Memory
    - Virtual Machines and Containers
    - Serverless Computing
- Concurrency and Parallelism
    - Models and Languages
    - Synchronization Mechanisms and Strategies
    - Distributed Systems
- Persistence
    - File Systems
    - Access Control
    - Cloud-based Storage

Course Schedule (subject to adjustment!)

Week	Work Due (by Monday 12PM)	% of Grade	Date of Class	Topic in Class
1	-	-	Sept 8	*Architecture and Assembly*
2	**Homework 1**	**5%**	Sept 15	*Virtualization*
3	**Homework 2**	**5%**	Sept 22	*Processes and Threads*
4	**Homework 3**	**5%**	Sept 29	*Virtual Machines and Containers*
5	**Homework 4**	**5%**	Oct 6	*Serverless Computing*
6	**Homework 5**	**5%**	Oct 12	*Concurrency and Parallelism*
7	**Homework 6**	**5%**	Oct 20	*Models and Languages*
8	**Course Mastery 1**	**15%**	Oct 27	*Synchronization Strategies*
9	**Homework 7**	**5%**	Nov 3	*Distributed Systems*
10	**Homework 8**	**5%**	Nov 10	*Persistence*
11	**Homework 9**	**5%**	Nov 17	*File Systems*
12	**Homework 10**	**5%**	Nov 24	*Access Control*
13	**Homework 11**	**5%**	Dec 1	*Cloud-based Storage*
14	**Course Mastery 2**	**15%**	Dec 8	*Project Proposals*
15	**Final Project Report**	**15%**	Dec 15	*Final Project Presentations*

The above percentages add up to 100%. Please note that some of these marks come from weekly in-class participation, explained below. No holidays fall on Thursdays this semester, but October 10th is Thanksgiving and November 11th is Remembrance Day, we will be discussing how we will be handling any mock interviews that land on these days!

Course Assessment

There are three main assessments in this course.

- **Homework (55%)** consist of programming assignments and literature reviews that will enable you to do a "deep dive" into systems topics. One part of each homework exercise will be a team based exploration of a deeper concept, handled in class. Participation is mandatory.

- **2 Course Masteries (30%)** consist of short answer questions, as well as several multi-part problems connecting different areas of the course, allowing you to synthesize what you have learned. Think of the Course Mastery as an take-home exam where you may consult your class notes but not your classmates or any online resources other than the ones that are explicitly permitted by the course instructor. Part of this mastery will be held as a code walk/interview style assessment with your TA.

- **1 Final Project (15%)** work occurs during the last two weeks of the course, in lieu of a final examination. Each individual/group will select a topic on any area of CS 5600 whose concepts we uncovered together in this course. Your group will submit a project proposal, a written report, and also deliver a presentation on the last day of the course.

We will use the following scale to convert numerical scores into letter grades:

A	93.00% – 100.00%
A-	90.00% – 92.99%
B+	86.00% – 89.99%
B	82.00% – 85.99%
B-	77.00% – 81.99%
C+	73.00% – 76.99%
C	69.00% – 72.99%
C-	65.00% – 68.99%
F	Less than 65.00%

Course Pedagogy

Our time in the classroom (virtual or otherwise!) will be devoted to learning activities. In Computer Science, we seldom get anything right on the first try. We see how an attempt turned out, and we try again. Often, any solution to a problem has a series of trade-offs, all of which must be considered! Our classroom activities will reflect this approach as well; so please be prepared to present and discuss your solutions, even if you're not sure that your answer is "right"!

When you come to class, we ask that you be fully present. No phones are permitted in the classroom. If you use a laptop, use it only to take notes or work on code. Please be respectful of your fellow students and instructors by participating attentively and non-disruptively.

To create and preserve a classroom atmosphere that optimizes teaching and learning, all participants share a responsibility in creating a civil and non-disruptive forum for the discussion of ideas. Students are expected to conduct themselves at all times in a manner that does not disrupt teaching or learning. Your comments to others should be constructive and free from harassing statements.

In order for this course to be a meaningful learning experience, you will need to come to each class well-prepared, with all assigned readings and videos complete, as well as your individual work finished to the best of your ability. This emphasis on pre-class work is the reason why our class meets for only 2 hours each week. If you do not complete the pre-class work, you will have a hard time following the in-class activities, which will make it that much harder for you to successfully complete the course. Please be prepared to spend a minimum of 20-25 hours per week on this course!

Course Forum

We have a Canvas page, on which we will post all assessments, class materials, pre-class readings, pre-class videos, and grades.

Textbook: Students are not required to purchase a textbook for this course, as there is an excellent free text online. Many more resources will be posted on Canvas. While these are not the only resources available on the web, these are the ones that I will be assigning and have identified as being most useful to students. I also encourage students to share resources that they find useful so that we can (if appropriate) add them to this list.

Course Discussions: Canvas will be used for class discussion and course announcements. It also provides students with a platform for getting you help fast and efficiently from classmates, the TAs, and the instructor. Rather than emailing questions to the teaching staff, we encourage you to post your questions on Canvas.

Course Policies

Accommodations

The goal is for every student to succeed in this course. If you require any accommodations (e.g. child care during class hours, extra time to complete assignments, support for a disability), let me know immediately so that we can work out appropriate arrangements. Speak to me at the end of class or contact me by email, and we will set up a time to meet during the first week of the course. I look forward to learning how we can be of service to you.

Students who have disabilities who wish to receive academic services and/or accommodations should visit the Disability Resource Center or call 844-688-6287. If you have already done so, please provide your letter from the DRC to the instructor early in the semester to arrange those accommodations.

Attendance and Participation

It is expected that you attend every class and participate. We begin each day at 10:00am sharp. If you must miss a class for any reason (e.g., illness, family emergency, religious observance), contact your instructor by email. Regardless of the reason, it is your responsibility to catch up on the material you have missed, and obtain the notes from a classmate (not from me).

Students who are absent repeatedly from class will be evaluated by faculty responsible for the course to ascertain their ability to achieve the course objectives and to continue in the course.

Assessments

With the exception of the in-class activities and the Final Project, all assessments are due at **12PM** on Monday: for your mock interview the following week. The course assessments are purposely due before class, so that you have time to complete all of the readings in preparation for the class.

Late Penalties

Any assessment that is late will be subject to a 50% penalty. You are allowed *one* exception to this policy, where you are allowed a reasonable extension to any assessment, with no penalty, provided you have a doctor's note or some other compelling reason. Additional exceptions will only be given under extenuating circumstances. Note that the Late Penalty only applies to Homework. The remaining assessments (Mastery, Final Project) must be submitted on time; failure to do so will result in an automatic zero.

Scheduling Meetings

At any time during the course, if you have any concerns, contact me by email or let me know after class, and we will set up a one-on-one meeting at a mutually convenient time.

If you need hints on the assessments, please wait until our scheduled class time, or use the question forum on Canvas or in Teams. For all other questions/concerns/issues, let's meet individually.

Technology

The class is held in-person. For some office hours and meetings with your TA, we will use Zoom (www.zoom.us). There may be extenuating circumstances when Zoom will be used for attending classes, but this is anticipated to be rare.

Students joining via Zoom will adhere to the same rules and expectations as those attending in person: being present, actively engaging in discussions, asking questions, and participating in group activities. Because you will be working in teams where some of your team members will be on campus while others will be joining remotely, we ask all students to be fully present during the class and ensure a healthy learning environment.

This requires that students in the classroom refrain from using their phones and keep them out of sight, and refrain from browsing non-course related topics. Students joining remotely will ensure that any distractions in their near surroundings are eliminated, or at least minimized to the best of their ability. Please create a distraction-free learning environment to optimize your learning.

For those of you joining via Zoom, we would all very much appreciate it if you could leave your video camera ON for the entire class. This enables us to see you all on my screen, so that we can better gauge the reactions of the class, appropriately pace the class, and more quickly respond to any questions you have. (If you prefer to leave your video camera OFF, especially for reasons of personal safety and comfort, then I will fully understand, but please let me know.)

Classroom Conduct

To create and preserve a classroom atmosphere that optimizes teaching and learning, all participants share a responsibility in creating a civil and non-disruptive forum for the discussion of ideas. Students are expected to conduct themselves at all times in a manner that does not disrupt teaching or learning.

Your comments to others must be constructive and free from harassing statements. You are encouraged to disagree with other students and the instructor, but such disagreements need to respectful and be based upon facts and documentation, rather than prejudices and personalities. The instructor reserves the right to interrupt conversations that deviate from these expectations.

Repeated unprofessional or disrespectful conduct may result in a lower grade or more severe consequences.

Title IX Policy

Title IX of the USA Education Amendments of 1972 protects individuals from sex or gender-based discrimination, including discrimination based on gender-identity, in educational programs and activities that receive federal financial assistance. Though our campus is located in Canada, all Northeastern University campuses follow the Title IX Policy.

Northeastern's Title IX Policy prohibits Prohibited Offenses, which are defined as sexual harassment, sexual assault, relationship or domestic violence, and stalking. The Title IX Policy applies to the entire community, including male, female, transgender students, faculty and staff.

If you or someone you know has been a survivor of a Prohibited Offense, confidential support and guidance can be found through University Health and Counseling Services staff and the Center for Spiritual Dialogue and Service clergy members. By law, those employees are not required to report allegations of sex or gender-based discrimination to the University.

Alleged violations can be reported non-confidentially to the Title IX Coordinator within The Office for Gender Equity and Compliance at: titleix@northeastern.edu and/or through calling 844-688-6287. Reporting Prohibited Offenses does NOT commit the victim/affected party to future legal action.

Faculty members are considered "responsible employees" at Northeastern University, meaning they are required to report all allegations of sex or gender-based discrimination to the Title IX Coordinator.

In case of an emergency, please call 911. Please visit http://www.northeastern.edu/titleix for a complete list of reporting options and resources, both on-campus and off-campus.

Collaboration and Academic Honesty

Computer science, both academically and professionally, is a collaborative discipline. In any collaboration, however, all parties are expected to make their own contributions and to generously credit the contributions of others. In our class, therefore, collaboration on assessments is encouraged, but you as an individual are responsible for understanding all the material in the assignment and doing your own work. Always strive to do your best, give generous credit to others, start early, and seek help early from both you professors and classmates.

The following rules are intended to help you get the most out of your education and to clarify the line between honest and dishonest work. The professor reserves the right to ask you to verbally explain the reasoning behind any answer or code that you turn in and to modify your project grade based on your answers. It is vitally important that you turn in work that is your own.

If you have had a substantive discussion of any assessment (homework) with a classmate, then be sure to cite them in your report. If you are unsure of what constitutes "substantive", then ask us or err on the side of caution. You will not be penalized for working together. You must not copy answers or code from another student either by hand or electronically. Another way to think about it is that you should be talking English with one another, not code. The following rules apply to anything you hand in for a grade.

- You may not copy anyone else's code or solution under any circumstances. This includes online sources.
- You may not permit any other student to see any part of your program or solution.
- You may not permit yourself to see any part of another student's program or solution.
- You may consult online resources as part of your course work, but you may not copy code or solutions from online sources. If you get an idea of how to solve a programming problem from an online source, include a short citation in a code block at the top of your code file.

As with all other courses at Northeastern, you are expected to adhere to the university's academic integrity policy (http://www.northeastern.edu/osccr/academic-integrity).

If you are unsure about the plagiarism policy, **please ask me!**

Feedback

Your opinions are very important to us. All students are strongly encouraged to use the Teacher Rating and Course Evaluation (TRACE) system, at https://www.northeastern.edu/trace/, to complete your course evaluations. A reminder about TRACE should arrive via email about two weeks before the end of the course.

In addition, I will be asking for your feedback at least once, about halfway through the semester. However, if you have concerns about the course, do not wait until you are asked. Please schedule a meeting with me, and we will discuss your concerns then.

Thank you for taking this course, and entrusting us to shape your education here at Northeastern. I am SO excited to serve as your instructor for CS 5600!