CS 5600 Computer Systems

Online Asynchronous / Instructor: Kai Yee Wan

Studies the structure, components, design, implementation, and internal operation of computer systems, focusing mainly on the operating system level. Reviews computer hardware and architecture including the arithmetic and logic unit, and the control unit. Covers current operating system components and construction techniques including the memory and memory controller, I/O device management, device drivers, memory management, file system structures, and the user interface. Introduces distributed operating systems. Discusses issues arising from concurrency and distribution, such as scheduling of concurrent processes, interprocess 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.

Upon completion of this course, you will be able to:

- trace the operation of context switching and program loading
- read part of an OS kernel and demonstrate an applied understanding of how abstract concepts apply to implementations and user programs
- use synchronization primitives (mutexes, semaphores, condition variables) to synchronize threads as demonstrated in a programming assignment
- describe operation of page tables and OS page faulting mechanisms for implementing demand allocation, demand loading, and copy-on-write
- understand performance characteristics of hard drives; optionally demonstrate knowledge of RAID configurations via a programming assignment
- understand permissions and access control lists as implemented in Linux and Windows - optionally describe common software exploits.

Prerequisites and time commitment

While the course does not have specific course prerequisites, you are expected to have reasonably strong experience in programming and a working knowledge of C. Some understanding of key concepts in computer science at the undergraduate level, including computer architecture, operating systems, multi-threaded programming, networking, discrete mathematics, data structures, and algorithms, is presumed.

A typical 4-credit graduate course in the Khoury College of Computer Sciences requires an average of 12-15 hours of work per week. Over a 14 week semester that amounts to about 200 hours of work which includes attending lectures and recitations, completing readings, learning activities, assignments, group discussions, case studies, practicums, among other work. If you cannot make that commitment, please reconsider your plans.

If you plan to travel during the term, schedule interviews, or attend private functions, you are still responsible to submit all work on time – be sure to manage your schedule and work ahead.

Course logistics

Materials

The textbook for this course is the manuscript “How Operating Systems Work” by Peter Desnoyer. This textbook is available at no cost to matriculated students at all Northeastern Campuses on Canvas. In addition, the course module contains videos, pre-recorded lessons, demonstrations, code walks, and thoughtfully curated external content.

The Final Exam must be completed online via Canvas in a two-hour block during a span of several days allocated during final exam week. It is fully online and may be completed from anywhere a stable and reliable internet connection is available. The answers to the final exam will not be made available. The final exam is a mix of multiple-choice, multiple-answer, true/false, essay, and programming questions.

We also offer diagnostic questions for most modules that you may use to determine your level of competency and as preparation for the final exam. They do not count towards your course grade and they do not have a due date.

Communication

Communication between instructor, teaching assistants, and students is through

- E-mail via the Canvas distribution list
- Announcements posted on Canvas
- Notes, discussions and clarifications posted on Piazza

Students are responsible for joining the class group on Piazza and for ensuring that all email addresses are properly configured. Missing an email that is sent to Spam or not enrolling in Piazza is not an excuse for any missed work or information.

You should check Piazza messages regularly. We recommend that you turn on notifications so that you do not miss important messages or announcements.

In most cases, Piazza is the preferred way to contact the instructor and the teaching assistants, as that ensures communication is delivered and does not accidentally get filtered into “spam” or “junk” folders.

Piazza discussions

Assistance should first be sought by posting on Piazza so that the answer is available to everyone. We try to get to each post as soon as we can, but please allow at least 24 hours for course staff to respond.

You're encouraged to offer your own responses or post follow-ups to your peers' posts on Piazza; that's a great way we all learn from each other! Follow the academic integrity policy on collaboration. On Piazza, you should talk about solution approaches at high-level general terms, or post pseudo-code. Please refrain from posting actual code written by yourself or from other sources (posting unmodified code excerpts from the original assignments is fine).

Sometimes, you might have to include some of your code in your post to help explain your problem or thinking. In such cases, make a private Piazza post that is visible only to the teaching staff. If you are not sure whether your post has too much solution detail, just make a private post on Piazza. The course staff can convert it to a public post later if appropriate.

Similarly, if you have some other question or issue that you want to discuss privately, you can make a private Piazza post visible only to one or more course staff, or optionally send an email.

Office hours

The TAs and I hold office hours during the times as published on Canvas. During those times you may seek individual assistance on matters regarding the materials or assignments that cannot be answered that cannot be answered as a post on Piazza.

Note that office hours are for you to get clarification on material and specific questions on assignments, but please do not expect course staff to debug your code in detail during office hours, or to "pre-grade" your assignment prior to submission.

Grading policy

Allocations

You will be assessed and graded through this breakdown:

- Homework (40%)
- Practicums (40%)
- Practicum Presentations (5%)
- Final Exam (15%)

The two items with the lowest score in the category "Homework" are dropped; the lowest grade is dropped for any reason (illness, travel, work, conflicts, personal reasons, procrastination, etc) – we do not require you to notify us and consequently we do not consider any excuses for a missing submission. A missing submission receives a score of 0. No other grades are dropped.

All graded items are weighted equally within each category. Some modules feature a quiz that assesses comprehension but are for diagnostics only.

The course requires a 70% overall score to pass the course with two additional requirements to pass the course: (1) the average of all practicums is at least 70% and (2) the final exam score is at least 70%. In other words, you cannot pass the course without getting a passing grade on the final exam and on the practicums. So, if you get a 65% on the final and get a 100% on everything else you will not pass. Of course, getting a 100% on the final and a 0% on everything else also means you will not pass as you did not meet the minimum passing grade for the course. In case a student scores below 70% on the final exam, the student will be contacted by the instructor for an oral examination or additional written work, which, if of sufficient quality, will be used to mark the final exam as passed. For final grade calculation purposes, however, the originally achieved grade on the final exam will be applied.

Submission of work

To receive full credit, all work for the course is expected to be completed by 11:59pm ET (Boston Time) on the due date and must be submitted via Canvas. To foster fairness, all deadlines and due dates are to be strictly observed. Any graded work that is submitted after the due date is accepted with a 2.5% penalty for each day late until the solution is published or discussed in class, or until a date and time set by the instructor.

Submissions via email, as attachments to Canvas comments, Canvas Inbox messages, Piazza, or through any manner other than via the Canvas assignment submission mechanism cannot be accepted under any circumstances. Any submissions received this way are not graded.

When submitting, attach all required files or documents along with explanatory comments. Once an item has been graded, students will be able to view the grade and feedback via the grade book. Multiple submissions are accepted but only the last submission will be considered. After submission, check that your submission was successful.

All work is expected to be done in a professional and timely manner and must be written in English free of grammatical and spelling errors or a reduction in points will result. Using any third party material, ideas, or direct quotes must be properly cited. Anything directly copied must be placed in quotes and must be cited using either APA or MLA formats.

Late submissions

Work submitted past the date when solutions are published cannot be accepted, even when the student registered for the class after the start of the term. While late submissions will not receive credit, a student may requested that they be graded for feedback.

Any requests for extensions cannot, out of fairness to all students, be considered. All due dates are set so that there is sufficient time to complete the work. Additionally, the two homework

assignments with the lowest score are dropped, which allows for travel, work, illness, personal issues, and other circumstances.

Not meeting a deadline when your computer fails or work is lost because it was not backed up is not an acceptable excuse. Be sure to have an alternative way to complete assignments in case of computer failure, e.g., borrow a computer, get a loaner from the University (Library or your Department), use a public computer on campus, use a secondary computer such as a ChromeBook, use posit.cloud, use repl.it, or a virtual machine on Azure, Google Cloud, or AWS, or similar. Consider frequently backuping your work onto a cloud drive (OneDrive, Google Drive, Dropbox, S3, or similar; all students have a subscription for cloud storage on OneDrive and Google Drive through the University). You may not backup to a public GitHub repository.

Regrading

If there is a material grading dispute, the student must contact the Grader who graded the work before contacting the instructor. When making any request for a revision of a grade, the student must clearly specify why the item was graded incorrectly, point to a correct solution, and state why their solution is correct.

A student may request a re-grading of a graded item by the instructor if (a) the student contacted the Grader first and the dispute cannot be resolved, and (b) the student provides a clear description as to why their solution is correct and that the loss of points is material.

Regrade requests must be made within 72 hours of the graded item's grade being published on Canvas. Regrade requests must be made via email directly to the instructor and only after disputes have been addressed through the Grader first. The re-grade request must be accompanied with a detailed explanation of why the assigned grade is incorrect and all correspondence with the Grader. The points in dispute must be material. In a re-grade, the instructor will not consider any prior grading of an item and will grade the item anew which may significantly increase or reduce the grade. The grade given after a re-grade is non-disputable and will replace any prior grades.

Accommodations

If you require any special considerations to support your learning, visit the DRC. Should the DRC approve accommodations, provide the instructor with a letter so that appropriate adjustments can be made as long as they are feasible and do not affect other students negatively. Unfortunately, we cannot provide any special accommodations unless there is a letter from the DRC. We do require that you provide us with 24 hour notification if you need extended time for a quiz, an assignment, or the final exam; an email to the instructor is sufficient. Extensions past the date at which solutions are published or discussed cannot be accommodated.

Academic integrity

The University views academic dishonesty as one of the most serious offenses that a student can commit and imposes appropriate punitive sanctions on violators. Here are some examples of academic dishonesty. While this is not an all-inclusive list, we hope this will help you to understand some of the things instructors look for.

Any incident of academic misconduct will result in a 0 for the graded item, a report to OSCCR, and a two-letter reduction in the final course grade or an F if it is on the final exam or especially egregious.

While you may discuss your assignments with others in the current class, we require that all of your work submitted for grading be your own (unless specifically stated otherwise, e.g., group work) and not copied in whole or in part from anyone.

Students are expected to read and understand the Northeastern University Academic Honesty Policy.

Acknowledgements

This course draws on the work of many of our faculty and prior versions of CS5600, including the work of Dr. Peter Desnoyers, Dr. Maria Jump, Dr. Jennifer Seitzer, Dr. David Choffnes, Dr. Mike Shah, and Dr. Julien Delange. We thank them for their efforts and acknowledge their contributions to this course. Beyond the faculty who created much of the material in this course, we also thank all of the students in prior instance of CS5600 at Khoury and other institutions where many of us previously taught for their comments, feedback, and suggestions.

Schedule

Here is a rough outline of the schedule for CS 5600 for reference. The actual schedule and content is revised from semester to semester, and small changes can still be made until end of the first month. You should always refer to the Canvas course website for the latest schedule.

Week#	Module
Week 1	Getting started, key resources and info
Week 2	Linux, shell navigation, and C

Week 3	Memory, processes, and files
Week 4	Operating systems organization
Week 5	Multiprocessing
Week 6	Synchronization
Week 7	Complex synchronization
Week 8	Virtual memory
Week 9	Block storage devices
Week 10	Practicum 1
Week 11	RAID
Week 12	File system organization
Week 13	Practicum 2
Week 14	Virtualization
Week 15	Final exam & conclusion