CS 4400: Computer Systems

Administrative Details and Syllabus
Fall 2023

Overview

Class Website	Canvas (available through CIS)
Lectures	Mondays and Wednesdays 11:50AM–01:10PM at FMAB AUD
Labs	Thursdays 09:40AM–10:30AM, 10:45AM–11:35AM, 11:50AM–12:40PM, 12:55PM–01:45PM, 03:05PM–03:55PM at WEB L130
Instructor	Mu Zhang
TA	Kangcheng Chen, Camron Wilson, Michael Sizemore, Shubham Mazumder, Aidan Naito, Samblesswin Stephenrajan
Textbook (required)	*Computer Systems: A Programmer's Perspective* by Bryant and O'Hallaron (3rd edition, 2016)
Final course grade	Assignments 55%, Exams 35%, Pre-lecture Canvas quizzes 10%
Prerequisites	CS 3810 and full-major status in CS in CE. CS 3505 strongly recommended
Important Dates	
Midterm Exam 1	September 27
Midterm Exam 2	November 6
Final Exam	December 14 10:30 am — 12:30 pm

Course Information

Description. The objective of CS4400 is to help students bridge the gap between high-level programming and actual computer systems: processors, the memory hierarchy, operating systems, compilers, linkers, assemblers, networks, and more.
Our basic goal is to understand how a computer works, so that as programmers we can make it work efficiently. Thus, this course is an introduction to computer systems from a programmer's point of view.
The official prerequisite for this course is CS 3810 (Computer Organization). *It is strongly recommended that students complete CS 3505 (Software Practice II) before taking this class.*

Deeply Technical and Broad Material. Due to the breadth of the topics covered in this course, there is a lot of material to absorb, and it will require significant effort outside of class to grasp the concepts. The textbook, videos, problems and code developed in class, programming solutions and lab sections are all designed to develop the necessary expertise to complete the assignments and succeed on the exams. The expectation is that the students will come to class already familiar with the material, so that we can focus the class lecture time on problem-solving and developing programming solutions.

Course Materials

Website. The class will use a Canvas website available through CIS. Here, the schedule, course notes, quizzes before lectures, examples, assignments and other course information will be provided, *updated weekly*. Materials for a given week will be posted by the end of the previous week so that students have plenty of time to prepare in advance of lectures.

Textbook. The required textbook is *Computer Systems: A Programmer's Perspective* by Randal E. Bryant and David R. O'Hallaron, 3rd edition, Prentice-Hall, 2016 (ISBN: 0-13-409266-X).
A highly recommended book is *The C Programming Language* by Brian W. Kernighan and Dennis M. Ritchie, 2nd edition, Prentice-Hall, 1988 (ISBN: 978-0131103627).

Videos. Most CS 4400 topics are covered in short videos posted in advance of each lecture. Students should watch such videos *before* the associated lecture. Each lecture will have a Canvas quiz assigned to ensure that students prepare for each lecture by watching videos and/or reading the textbook. No late quizzes will be accepted.

Course notes. The instructor often makes use of slides, sample problems, source code and other materials during lecture. These items are posted on the class website following the lecture; however, such posted items may not represent completely the material covered in class. Students who must miss class are strongly encouraged to check with a classmate.

Student Evaluation

Assignments. A significant aspect of the learning experience for this material is attained by hands-on programming to interact directly with the layers of abstraction in computer systems. Consequently, the lab work makes heavy use of C, Unix, and the Intel IA64 (x86) architecture. Students not currently fluent in any of these three topics should not panic, as this course will cover them in more detail throughout the semester. However, there is an assumption that students have some familiarity with C or C++. Students should be prepared to learn some of the C programming language on their own, for which the Kernighan and Ritchie reference text will be very useful.
To behave properly, all assignments are configured to run on a CADE Lab 1 machine. Dependencies such as the version of compiler, operating system, or shared libraries, you are using can impact correctness of your assignment. Students who choose to develop their code on any other machine must run their assignments on a CADE Lab 1 machine before turning it in. Unless explicitly noted otherwise, grading of assignments will be done using CADE Lab 1 machines. *There will be no credit for programs that do not compile and run on a CADE Lab 1 machine*, even if they run somewhere else. For more information on the CADE lab and how to remotely log into these machines, see `http://www.cade.utah.edu`.
Programming assignment deadlines are strict, due via Canvas submission by 11:59PM on the posted due date. Late programming assignments are accepted according to the following rules.

- Assignments are not accepted more than 3 days after the due date.
- Assignments submitted any time X days after the due date (midnight to 11:59PM) are penalized $X \times 10\%$ of the assignment grade.

It is the student's responsibility to ensure the successful and timely submission of each assignment – start early and follow the instructions carefully. Corrupted or missing files are not grounds for extensions – double-check your submissions and save a digital copy of all of your work in your CADE account.

Exams. Two midterm exams will take place on September 27 and November 6. The final exam will take place in person on December 14 10:30 am – 12:30 pm.

Pre-lecture Canvas quizzes. To ensure that students prepare adequately before each lecture by watching videos and/or reading the textbook, Canvas quizzes are assigned regularly. You will have two attempts to take the quiz; they are automatically graded and the highest score of two tries will be recorded. Quizzes cannot be taken late. Solutions to the problems will be discussed in class.

Final course Grade. The final course grade will be based on a number of evenly-weighted lab-work assignments (55% total), two evenly-weighted midterm examinations (20% total), a final examination (15%), and weekly quizzes (10%).

Regrades. Students who wish to appeal a score on an assignment or an exam must do so within one week of receiving the score.

Getting Help

Instructor office hours. 3:30 – 5PM Mondays and Wednesdays, unless otherwise indicated.

Teaching assistants and consulting hours. See Canvas for the consulting schedule of the course TAs.

Communication. For questions outside of class and consulting hours, students are encouraged to post a question to the Q&A forums on Piazza (`https://piazza.com`), or contact the course staff directly (also via Piazza). Whenever the question is a clarification on the assignment and not giving away the answers, feel free to post to the entire class. When in doubt, only send the question to the TAs and Instructor.

Course Guidelines

Students are bound by policies and guidelines from the university, College of Engineering, School of Computing, and specifically for this course, described in the documents listed below.

- CS4400 Academic Misconduct Policy, posted on the Canvas website under `Admin/policy.pdf`.
- Kahlert School of Computing Policies and Guildelines `handbook.cs.utah.edu/2023-2024/CS/Academics/policies.php`.
- College of Engineering Guidelines `www.coe.utah.edu/students/current/semester-guidelines/`
- UofU Student code `www.regulations.utah.edu/academics/guides/students/studentRights.html`

Students should read and understand each of these documents, asking questions as needed.

Inclusivity Statement

It is our intent that students from all diverse backgrounds and perspectives be well-served by this course, that students' learning needs be addressed both in and out of class, and that the diversity that the students bring to this class be viewed as a resource, strength and benefit. It is our intent to present materials and activities that are respectful of diversity: gender identity, sexuality, disability, age, socioeconomic status, ethnicity, race, nationality, religion, and culture. Your suggestions on how we can make the course more inclusive and welcoming are encouraged and appreciated. We also expect students to treat others in the class, including the teaching staff, with the same level of respect. We take incidents of discrimination, bias, and harassment seriously. We will file reports with the Office or Equal Opportunity, Affirmative Action, and Title IX (OEO) about such incidents. If you are unsure what differentiates free speech and professional behavior from discrimination, bias, and harassment we are happy to have an open, judgment-free, and confidential conversation with you, or refer you to the OEO.

The Americans with Disabilities Act

The University of Utah seeks to provide equal access to its programs, services, and activities for people with disabilities. If you will need accommodations in this class, reasonable prior notice needs to be given to the Center for Disability Services, 162 Olpin Union Building, (801) 581-5020. CDS will work with you and the instructor to make arrangements for accommodations. All written information in this course can be made available in an alternative format with prior notification to the Center for Disability Services.

University Safety Statement

The University of Utah values the safety of all campus community members. To report suspicious activity or to request a courtesy escort, call campus police at 801-585-COPS (801-585-2677). You will receive important emergency alerts and safety messages regarding campus safety via text message. For more information regarding safety and to view available training resources, including helpful videos, visit safeu.utah.edu.

Addressing Sexual Misconduct

Title IX makes it clear that violence and harassment based on sex and gender (which Includes sexual orientation and gender identity/expression) is a civil rights offense subject to the same kinds of accountability and the same kinds of support applied to offenses against other protected categories such as race, national origin, color, religion, age, status as a person with a disability, veteran's status or genetic information. If you or someone you know has been harassed or assaulted, you are encouraged to report it to the Title IX Coordinator in the Office of Equal Opportunity and Affirmative Action, 135 Park Building, 801-581-8365, or the Office of the Dean of Students, 270 Union Building, 801-581-7066. For support and confidential consultation, contact the Center for Student Wellness, 426 SSB, 801-581-7776. To report to the police, contact the Department of Public Safety, 801-585-2677(COPS).

Syllabus

The following are the key topics planned for study, and the corresponding chapters in the course text.

Introduction Chapter 1

- Administrative details
- Overview of computer systems

Representing Information Chapter 2

- Bits and bytes (information storage)
- Integers (representation, arithmetic)
- Floating point (representation)

Representing Programs Chapter 3

- x86 machine-level code (accessing information, operations)
- Control flow (jumps, branches)
- Procedures (run-time stack, recursion)
- Data (arrays, pointers, structures, alignment)

Optimizing Code Chapter 5

- Optimizing compilers
- Loops
- Branch prediction
- Memory performance

The Memory Hierarchy Chapter 6

- Different kinds of memory
- The principle of locality
- Cache memory

Running Programs on a System Chapters 8,10

- Exceptions
- Processes
- Signals
- System-level I/O

Memory Management Chapter 9

- Virtual memory and address translation
- Dynamic memory allocation

Interaction Among Programs Chapters 11–12

- Network programming
- Concurrent programming
- Synchronization

Linking Chapter 7

- ELF Format
- Relocation