



CSCI 356 Introduction to Computer Systems

Units: 4

Fall 2018

Location: SLH 100 and at <http://bytes.usc.edu/cs356>

Instructor: Mark Redekopp

Office: EEB-222

Office Hours: See website

Teaching Assistant:

See website

IT Help: Group to contact for technological services, if applicable.

Hours of Service:

Contact Info: Email, phone number (office, cell), Skype, etc.

Course Description

This course covers computer systems hardware organization and the programmer interface with the goal of improving students' abilities to reason about the execution of their programs, write system software, and enhance the performance of the programs they write. This course will also serve as a basis for other systems courses, such as CSCI 350 (Operating Systems), CSCI 450 (Computer Networks), or CSCI 457 (Computer Systems Organization).

Concepts include information representations, assembly language programming and the nuances of the x86 instruction set, the memory hierarchy including DRAM and cache, address translation and virtual memory, instruction execution on a modern processor with out-of-order execution, along with compilation and system software concepts such as linking and heap management.

Six programming assignments will provide the opportunity for students to apply the skills they have gained in the context of real applications. Many assignments will involve reverse engineering machine code or attempting to optimize performance of certain code kernels. Along the way use of debuggers and other binary tools will be taught and practiced.

The fundamental concepts and skills learned in this class underpin the modern state-of-the-art of computer system organization and will be the basis for future courses in operating systems, compilers, networks, and computer architecture.

Learning Objectives

Below are the specific, measurable skills a student will demonstrate by the end of the course. These objectives will be both taught and assessed in the course and are aligned with the assignments, assessments and learning materials.

1. Translate bit strings to appropriate numbers using unsigned, 2's complement, and IEEE standard floating point representation systems
2. Reverse engineer machine code and assembly code to a behavioral (high-level) description
3. Translate high-level software code to corresponding x86 instruction sequences.
4. Assess the cache performance of a system given its memory/cache specifications and a specific address trace
5. Identify various software vulnerabilities and how they may be exploited
6. Manually simulate the address translation process as a means of understanding the hardware and software components that do likewise
7. Experiment to determine efficient storage (specifically heap memory) allocation strategies.
8. Organize code and use compiler settings to achieve enhanced performance on specific processor architectures

Prerequisite(s): CS 104L

Co-Requisite(s): None

Concurrent Enrollment: course(s) that must be taken simultaneously

Recommended Preparation: None

Course Materials

- All content will be provided on our website. We will post lecture slides/notes BEFORE each lecture and it is **STRONGLY** encouraged that you print and bring the set of notes to class with you each lecture.
- The required textbook for the course is **Computer Systems: A Programmer's Perspective, Third Edition by Bryant and O'Hallaron (Pearson, 2016, ISBN 978-0134092669)**.

Course Websites

1. **Primary website:** All course assignments, content, office hour information, etc. will be posted at our main website: <http://bytes.usc.edu/cs356>.
2. **Q&A website:** A Q&A and announcement website will be utilized: <http://www.piazza.com/>. All official announcements regarding assignments, lectures, exams, etc. will be made via Piazza. It is your responsibility to check this site often.
3. **Blackboard:** Blackboard (<http://blackboard.usc.edu>) will also be used to record homework and exam grades.

Technological Proficiency and Hardware/Software Required

This course requires you have access to a computer/laptop able to run the course virtual machine which we will provide via our website. Your computer must be able to run Oracle VirtualBox to use the provided virtual machine image. Please visit the course website for more information.

You will also be provided access to a private Github repository where you must commit and push all of your code submissions. You are expected to be familiar with basic 'git' and Github skills.

Required Readings and Supplementary Materials

The following textbooks are **required**. We recommend you read the sections listed on the course schedule below for the corresponding week **BEFORE** attending the first lecture of that week.

1. Computer Systems: A Programmer's Perspective, Third Edition by Bryant and O'Hallaron (Pearson, 2016, ISBN 978-0134092669). *Available at the bookstore and or from an online retailer.*

Description and Assessment of Assignments

What kind of work is to be done and how should it be completed, i.e. how the learning outcome will be assessed. Include any assessment and grading rubrics to be used.

Homeworks

Availability: Assignments will be made available on the course web site (<http://bytes.usc.edu/cs356>) and are due on the date posted on our website.

Submissions: Your assignments must be pushed to your class-provided private repository on Github. **THEN**, you must submit the full SHA (not just the 7-digit summary) of your commit via our website. The submission link will be posted alongside the due date and assignment link on our website's assignment page.

Late Submission: You will be allowed **5 grace days** over the semester. You may submit homeworks up to 48 hours (2 days) late provided you still have remaining grace days. **Thus, you may only use 2 grace days per assignment.** If you do not have grace days or it is 48 hours past the deadline, no submission will be accepted. If you are 1 minute late, it will require you to use a full grace day.

Grading and Assessment: Homework questions will include a point total that indicates the value of the assignment and each subproblem. For most homeworks, a script will be provided to allow you to run the **SAME** tests we will run for grading, and even show you your final score **BEFORE** you submit (provided you follow submission instructions correctly).

Solutions: Solutions to the homework problems will **NOT** be provided. However, you are welcome and encouraged to ask the instructor, other students, or other course staff about any problems you could not solve correctly.

Exams

Time and Location: There will be two midterm exams and one final. The midterm exams will be held during class. The date of the midterm are shown on the attached schedule but may be moved to a different date in exceptional cases. The exams may also be moved to a different classroom. Always check with the instructor as the listed exam date approaches to confirm the date and time. You are responsible for finding out when and where the exams will be held. Makeup exams will be given if you have a valid excuse (e.g. serious illness or accident but proof will be required).

Academic Accommodations: If you have USC approved academic accommodations, please check with your instructor 2 weeks before the exam to determine when and where you will take the exam.

Exam Style: Exams are designed to not only test your retention of the material but your ability to apply it to design and analyze new or novel problems. In this way, your mastery and depth of understanding of the course content will be assessed. Some portion of the exam will contain general knowledge questions and be fill-in/multiple choice. However, the majority of points will come from design/analysis problems using skills learned in class. This is where struggling with the homeworks and practice problems given in-class, discussion, and on our exam preparation page until you truly understand and feel comfortable with each concept will greatly pay off. *Students who simply "get the homeworks done" without reviewing and understanding each facet will often struggle on the exams.*

Preparation: Practice problems and exact topics for the exams will be posted on the class website under the **Exam Info** page.

Grading Breakdown

Including the above detailed assignments, how will students be graded overall? Participation should be no more than 15%, unless justified for a higher amount. All must total 100%.

| Assignment | Points | % of Grade |
|---------------|----------|------------------------------|
| Homeworks 1-6 | Various | 30% (equally weighted) |
| Worst Midterm | 100 pts. | 15% |
| Best Midterm | 100 pts. | 25% |
| Final | 100 pts. | 30% |

Grading Scale:

Course final grades will be determined using the following scale. If the grade distribution is lower than expected the scale may be shifted downward but will never be shifted upward.

| | | | | | | | | | |
|----|--------|----|-------|----|-------|----|-------|---|--------------|
| A | 94-100 | B+ | 87-89 | C+ | 77-79 | D+ | 67-69 | F | 59 and below |
| A- | 90-93 | B | 83-86 | C | 73-76 | D | 63-66 | | |
| | | B- | 80-82 | C- | 70-72 | D- | 60-62 | | |

Assignment Rubrics

See the section above for relevant assessment procedures for homeworks.

Assignment Submission Policy

Submission policies are outlined with the relevant assignment type in the sections above.

Grading Timeline

Homework grades will generally be posted within 2 weeks of submission. However, the most homeworks will contain grading scripts that allow you to determine your assignment grade without waiting for our course staff to post the grades.

Exams will generally be graded within 1 week of the exam date.

Additional Policies

None

Course Schedule: A Weekly Breakdown

Provide a detailed course calendar that provides a thorough list of deliverables—readings, assignments, examinations, etc., broken down on at least a weekly basis. The format may vary, but the content must include:

IMPORTANT:

In addition to in-class contact hours, all courses must also meet a minimum standard for out-of-class time, which accounts for time students spend on homework, readings, writing, and other academic activities. **For each unit of in-class contact time, the university expects two hours of out of class student work per week over a semester.**

| | Topics/Daily Activities | Readings and Homework | Deliverable/ Due Dates |
|----------------|--|-----------------------|---|
| Week 1 | Overview Binary Representation | Chapter 1, 2.1 | |
| Week 2 | Integer Operations Floating Point Representation | 2.2 - 2.4 | |
| Week 3 | More Floating Point Assembly Intro. | 2.4 3.1-3.4 | HW 1 due |
| Week 4 | More Assembly Control | 3.5 3.6 | |
| Week 5 | Procedures Data structuring | 3.6- 3.8 | HW 2 due |
| Week 6 | Stacks and Exploits Exploits | 3.9, 3.10 | |
| Week 7 | Exam I Memory Hierarchy | 6.1-6.3 | HW 3 due |
| Week 8 | Caching | 6.4-6.7 | |
| Week 9 | Address Translation Virtual Memory | 9.1-9.4 | HW 4 due |
| Week 10 | Virtual Memory Dynamic Memory Allocation | 9.5-9.8 9.9 - 9.12 | |
| Week 11 | Mem Allocation Linking | Ch. 7 | HW 5 due |
| Week 12 | Process Organization Exam II | Ch. 4 | |
| Week 13 | Out-of-Order Execution | Ch. 4 | |
| Week 14 | Code Optimization Holiday | Ch. 5 | HW 6 due |
| Week 15 | Cache Coherency Review | Instructor Notes | |
| FINAL | Thurs. Dec. 6 th , 2-4 p.m. | | Date: For the date and time of the final for this class, consult the USC <i>Schedule of Classes</i> at classes.usc.edu . |

CSCI 356 Academic Honesty Supplement

The following are a supplement for this course to the university academic honesty guidelines.

- Any code obtained with help of a course producer, TA, or instructor must be *clearly marked in comments* with who and when. This may not constitute a meaningful portion of your project. The substring “**assistance from**” must appear in the comment acknowledgement near the code on which you received assistance, followed by the name of who you got assistance from.
- The help you receive from classmates should be limited to *conceptual* help -- how an algorithm you need to implement works as a “big picture” rather than at the level of code.
- If you receive help from others, whether an instructor, course producer, or fellow student, follow the *30-minute Rule*:
 - You may discuss high-level ideas and receive hints regarding how to solve portions of the assignments. However, neither party should keep any written record from this discussion. Afterwards, take a 30-minute break and do something unrelated to the course (watching an episode of your favorite cartoon show, for example). You may now return to your assignment.
 - When you write a section of code based on help received, add a comment acknowledging the help, including the substring “**assistance from**” as part.
- You are **explicitly prohibited** from seeking help outside of course resources for the programming projects. The following is an **exhaustive** list of “course resources”:
 - The instructor, TA(s), and course producers.
 - Your fellow students. Remember that this means discussing concepts, not sharing code.
 - The textbook, Randal E. Bryant and David R. O’Hallaron, *Computer Systems: A Programmer’s Perspective, Third Edition (CS:APP3e)*, Pearson, 2016.
 - The *public* portion of the textbook’s website.
 - The course Piazza page for this semester.
 - Course lectures and discussions, along with any notes provided by instructors.
 - The supplemental textbook, *The C Programming Language* by Brian Kernighan and Dennis Ritchie
- The previous bullet point means that if you seek information towards solving part of a programming assignment online, find it, and use it, you risk this as an academic honesty violation. *Do not search for anything related to the assignments online for any reason without explicit permission from the instructor. This includes “clarification” and “for reference only”*
- If you use code fragments from one of the textbooks mentioned above, you must include a comment acknowledging the source, including the substring “**assistance from**” and the textbook citation (textbook name, authors, and page number is sufficient).
- If you are using git, use your *private repository* so your code is not available to your fellow students. Course staff will help set you up with a private repository early in the semester.
- **Violations of this code will result in referral to the Student Judicial Affairs Committee. The USC policy is any violation shall result in an F in the course.**

Statement on Academic Conduct and Support Systems

Academic Conduct:

Plagiarism – presenting someone else’s ideas as your own, either verbatim or recast in your own words – is a serious academic offense with serious consequences. Please familiarize yourself with the discussion of plagiarism in *SCampus* in Part B, Section 11, “Behavior Violating University Standards” policy.usc.edu/scampus-part-b. Other forms of academic dishonesty are equally unacceptable. See additional information in *SCampus* and university policies on scientific misconduct, <http://policy.usc.edu/scientific-misconduct>.

Support Systems:

Student Counseling Services (SCS) – (213) 740-7711 – 24/7 on call

Free and confidential mental health treatment for students, including short-term psychotherapy, group counseling, stress fitness workshops, and crisis intervention. engemannshc.usc.edu/counseling

National Suicide Prevention Lifeline – 1 (800) 273-8255

Provides free and confidential emotional support to people in suicidal crisis or emotional distress 24 hours a day, 7 days a week. www.suicidepreventionlifeline.org

Relationship and Sexual Violence Prevention Services (RSVP) – (213) 740-4900 – 24/7 on call

Free and confidential therapy services, workshops, and training for situations related to gender-based harm. engemannshc.usc.edu/rsvp

Sexual Assault Resource Center

For more information about how to get help or help a survivor, rights, reporting options, and additional resources, visit the website: sarc.usc.edu

Office of Equity and Diversity (OED)/Title IX Compliance – (213) 740-5086

Works with faculty, staff, visitors, applicants, and students around issues of protected class. equity.usc.edu

Bias Assessment Response and Support

Incidents of bias, hate crimes and microaggressions need to be reported allowing for appropriate investigation and response. studentaffairs.usc.edu/bias-assessment-response-support

The Office of Disability Services and Programs

Provides certification for students with disabilities and helps arrange relevant accommodations. dsp.usc.edu

Student Support and Advocacy – (213) 821-4710

Assists students and families in resolving complex issues adversely affecting their success as a student EX: personal, financial, and academic. studentaffairs.usc.edu/ssa

Diversity at USC

Information on events, programs and training, the Diversity Task Force (including representatives for each school), chronology, participation, and various resources for students. diversity.usc.edu

USC Emergency Information

Provides safety and other updates, including ways in which instruction will be continued if an officially declared emergency makes travel to campus infeasible. emergency.usc.edu

USC Department of Public Safety – UPC: (213) 740-4321 – HSC: (323) 442-1000 – 24-hour emergency or to report a crime.

Provides overall safety to USC community. dps.usc.edu