

University of California, San Diego  
**CSE 142: Computer Architecture: A Software Approach**  
Winter 2024

### **Welcome!**

You've been writing programs for probably two years or more and your programs have always ran, in some way or another, on computer hardware. For the most part, you haven't had to think that much about how that hardware executed your code. Now, you have had CSE 30 which taught you about assembly language and some basics of computer hardware, but you are likely unclear on some of the details. More importantly, you have spent a number of terms learning how to analyze a program's performance theoretically, but likely haven't spent much time thinking about how code runs on real systems. So, this is a unifying course - it brings together your knowledge of high-level code, what you learned in CSE 12, 21, 100, and 101 about theoretical runtime analysis, what you learned in CSE 30 about assembly language and computer organization, and (for those of you who have already taken it) what you've learned about digital logic in CSE 140.

Ultimately, this is one of a series of courses which demystifies computing. After completing compilers, operating systems, and computer architecture, you will have a much better understanding of what happens behind the scenes when your programs execute. And this is valuable whether you plan on working in architecture/systems or you just hope to write code which performs well.

### **What does this course offer to you?**

This course is designed for two central purposes. For those of you who plan to have a career in architecture, hardware, or systems this course will likely be the first of many on how modern processors are designed.

For those of you who plan on working in software engineering, this course will give you the fundamentals you need to understand how your code works. This course isn't like CSE12, where you use the basic ideas of data structures nearly every day as a programmer. This course is for the inevitable day when your code is too slow or your code isn't working as intended. **Writing high performance code requires a solid knowledge of hardware to achieve its goals.** Likewise, should you ever find yourself debugging a compiler or, worse, hardware, these ideas are paramount.

### **How, exactly, are you going to accomplish this?**

By learning how to optimize various programs to take advantage of processor features. The lecture (CSE142) will prepare you with the conceptual understanding of processor features and the lab (CSE142L) will give you an opportunity to put those ideas into practice.

### **How will you (and the professor) know if you are making progress in your learning?**

The course offers you many opportunities to get feedback on whether you are learning what you need to know. You know learning about computing isn't done by just reading about it, so you'll be asked to solve problems related to the class and work on a large project in the lab. Beyond learning the topics of this course, I care a lot about you developing your general skills in technical analysis and communication. So throughout the class, you will be able to get practice and feedback in the following ways:

- **Reading quizzes:** Before lecture you will often complete a reading from the text and a brief online reading quiz to check that you got the key ideas from the reading.
- **Homework:** This is your opportunity to see if you understand the course material. Try your best to work through the homework entirely on your own, but feel free to get help from the tutors, TAs, or professor. (If you want some help from friends, please see the Academic Integrity rules for the course.) We'll make every effort to return your homework quickly and to release solutions so you can get feedback on your work.
- **Peer Instruction Questions:** During lecture, you will deepen your understanding of computer architecture concepts while developing technical communication skills by discussing challenging topics with other students.
- **Lab:** The separate lab course helps to reinforce and solidify your understanding of the concepts from this class. **Moreover, it gives you the practical experience in optimizing programs for hardware that you'll need in your career.**

We encourage you to make the most of this feedback to ensure that you perform well on the course exams!

**WARNING:** CSE141 and CSE142L are incompatible as are CSE 142 and 141L. Although there is some overlap in content between CSE141 and CSE142, the focus of each class is substantially different. If you take CSE142 this quarter hoping to take CSE141L in the future, you will find it exceptionally difficult to succeed in CSE141L.

### **Important Course Details**

**Instructors:** Leo Porter (Lecture) and Steven Swanson (Lab)

**Class website:** [canvas.ucsd.edu](https://canvas.ucsd.edu)

All Course materials will be on canvas and/or piazza this quarter. Please go to [canvas.ucsd.edu](https://canvas.ucsd.edu) and piazza to login (signup here: <https://piazza.com/ucsd/winter2024/be6f>) . **Please direct all class questions to piazza.** You are responsible for reading and staying up to date with the class website. Announcements, assignments, etc. will be posted on this site and on piazza (see **piazza** for homework, concept questions). See **gradescope** (linked from canvas) for homework submission.

**Meeting times (all times are Pacific) and places:**

- See UCSD schedule of classes for details
  - **Final: Saturday March 16<sup>th</sup> (both sections)**

**Course materials (required)**

- Bryant, "Computer Systems", Third Edition
- Dive Into Systems by Suzanne J. Mathews, Tia Newhall, and Kevin C. Webb:
  - <https://diveintosystems.org/>

**Other recommended reading**

- Patterson & Hennessy, "Computer Organization and Design -- The Hardware/Software Interface", Morgan Kaufmann, Fifth Edition
- Hennessy & Patterson, "Computer Architecture: A Quantitative Approach", 5th edition

### **Class Announcements**

All announcements, updates on homework assignments, etc. will be posted on canvas and/or piazza. All students are responsible for announcements and information on canvas and piazza.

### **Lecture Notes**

I will lecture writing on ppt slides and will release my inked slides as pdf after class.

### **Course Outline**

- I. Computer System Performance and Performance Metrics
- II. x86 Assembly and Instruction Set Architectures
- III. The Memory/Cache Hierarchy
- IV. Virtual Memory
- V. Pipelining and Speculation
- VI. Instruction Level Parallelism
- VII. Memory Level Parallelism
- VIII. Multicore Processors
- IX. Simultaneous Multithreading
- X. Vectors and Floating Point
- XI. Hardware Security (if time)

### **Grading Information:**

- The grade for this class (out of 100% total) will be as follows:
  - Reading and other online quizzes: 3%
  - Iclicker participation: 0-5% (see participation explanation below)
  - Professionalism: 1%
  - Homework: 25%
  - Midterm: 30% **Thursday, February 7th**
  - Final: 36-41% **Saturday, March 16th**
- **Reading and other online quizzes:** You are expected to come to class prepared to learn and that means you should do the assigned reading and complete the assigned reading quiz. In some cases, quizzes will be assigned related to course content, but not necessarily reading quizzes. The combination of coming to class prepared and participating in class should enable you to excel throughout the class.

- **Participation:** You are highly encouraged to attend class and participate through iclicker questions and discussion. However, if you have personal reasons for not wanting to join the class, you can choose not to attend and still receive a perfect grade in the class (however your final exam will be weighted more). Participating in a lecture is defined as responding to at least 80% of iclicker questions in that lecture with your clicker device. If you participate in 80% of lectures, you receive 100% for 5% of your grade (your participation grade). If you participate in fewer than 80% of lectures, your final exam score replaces that portion of your participation grade. **Be careful to click in both for the individual vote and group vote to ensure you answer >80% of the questions.** Some examples:
  - $\geq 80\%$  lecture participation: You receive 100% for your 5% participation grade and your final exam is worth 36% of your grade.
  - 0% lecture participation: Your participation portion of your final grade is 0% and your final exam is worth 41% of your grade.
  - 60% lecture participation: You receive 100% for 3% (60% of 5%) of your final grade for participation. Your final exam is worth 38% (36%+2%) of your final grade.
- **Professionalism:** I expect everyone in the class to conduct themselves in a professional manner. *I consider professional behavior to be a program-level academic outcome of UCSD.* Though broadly defined here, it includes (at least), professional conduct with the teaching staff and your fellow classmates. Some examples of unprofessionalism in prior courses include: excessive arguing with teaching staff over assessment outcomes (grades), belittling/rude/unkind behavior toward other students or teaching staff, and excessive lack of resourcefulness (e.g., e-mailing course staff with questions already answered on piazza or in this syllabus). Though rare, I reserve the right to deduct participation points from repeated unprofessionalism. Note that particularly severe infractions (e.g., sexism, racism, dishonesty - which are never tolerated in our community) may be subject to campus Academic Conduct Charges.
- **Online Surveys:** Periodically, we'll ask you for feedback about the course and assign course credit to encourage your participation and reward your effort as part of your reading quiz score.
- **Homework:** Homework allow you test your understanding of the material and gain feedback on that understanding.
  - To facilitate quick feedback, homework **MUST** be submitted as directed through gradescope. Be sure to follow instructions for your homework to be graded.
  - Everyone will have an automatic 1-day extension to turn in homework late with no penalty that can be used on every homework. For example: if a homework is due on Tuesday at 10pm, everyone has a 1-day automatic extension to turn it in at Wednesday at 10pm.
  - **Late homework assignments are not allowed (after the exception), no exceptions.** We will make every effort to return assignments to you and post solutions in a timely manner -- limiting your ability to turn things in late is, unfortunately, critical to that goal. **You may drop your lowest homework grade – use that dropped score judiciously!**
  - You may use gradescope regrades to identify grading errors on homeworks. **ONLY fully correct solutions which are incorrectly marked are eligible for regrading** (do not use regrades to argue for additional partial credit).
  - You are highly encouraged to discuss homework problems with the professor, TAs, and tutors in office hours. If you do not understand a concept, it pays to address it as soon as possible.
- **Exams:**
  - **Midterm:** See date above. Exams must be taken with your enrolled section.
  - **Final exam:** The final will be inclusive of all course material.
  - **Alternative/make-up exams are only offered in exceptional circumstances and need to be approved prior to the start of the exam. If such an exceptional circumstance exists, the student should notify the instructor as early as possible.**
    - All exams will be given in-person.
    - You have the right of appeal for grading on all tests. Please check your exam over carefully when you receive it and be sure to request a regrade in the case of a grading error. Also review your exam to understand where you made errors, if in doubt, come to see us in Office Hours (do not use regrade requests to find out what you did wrong). Note that frivolous regrade requests may result in additional points deducted.
  - If you are taking the course pass/fail, you must get at least a C- to pass (for Sat/Unsat, a B-).

- **The only exceptions to the rules regarding no late assignments or exams are extended absences (one week or more) due to verifiable extraordinary circumstances**, and absences due to official UCSD activity travel. In the case of absences due to a UCSD activity travel, provide me with the list of your travel dates as soon as possible.
- **If you are eligible for accommodations as per UCSD OSD policies, contact me by the end of week 2 to get them organized.**

### **Post Pandemic Policy**

- **Please see campus guidelines for the authoritative campus policy regarding vaccinations, mask guidance, expectations for in-class attendance, etc.**
- **Please do NOT come to class sick.** Please take care of yourself and try to recover quickly. The class participation policy allows you to miss 4 classes with no impact to your participation grade and missing more than 4 classes can be replaced by your final exam score. The instructor will also honor this agreement by teaching classes online if the instructor feels ill.
- Please take care of your health. Get sleep, exercise, eat well, wash hands, etc.

### **Diversity and Inclusion**

We are committed to fostering a learning environment for this course that supports a diversity of thoughts, perspectives and experiences, and respects your identities (including race, ethnicity, heritage, gender, sex, class, sexuality, religion, ability, age, educational background, etc.). Our goal is to create a diverse and inclusive learning environment where all students feel comfortable and can thrive.

Our instructional staff will make a concerted effort to be welcoming and inclusive to the wide diversity of students in this course. If there is a way we can make you feel more included please let one of the course staff know, either in person, via email/discussion board, or even in a note under the door. Our learning about diverse perspectives and identities is an ongoing process, and we welcome your perspectives and input.

We also expect that you, as a student in this course, will honor and respect your classmates, abiding by the UCSD Principles of Community (<https://ucsd.edu/about/principles.html>). Please understand that others' backgrounds, perspectives and experiences may be different than your own, and help us to build an environment where everyone is respected and feels comfortable. If you experience any sort of harassment or discrimination, please contact the instructor as soon as possible. If you prefer to speak with someone outside of the course, please contact the Office of Prevention of Harassment and Discrimination: <https://ophd.ucsd.edu/>.

### **Integrity**

- **Review and sign** the course Integrity of Scholarship Agreement (on canvas, submit on gradescope)
- Cheating WILL be taken seriously. It is not fair to honest students to take cheating lightly, nor is it fair to the cheater to let him/her go on thinking that cheating is a reasonable alternative in life.
- The following is *not* considered cheating:
  - discussing homework in groups (with the write-up done separately, later).
- The following is considered cheating:
  - discussing homework with someone who has already completed the problem or looking at their completed write-up.
  - using textbook hw solutions from the web, previous versions of the class, or anywhere else.
  - receiving, providing, or soliciting assistance from another person/device during a test.
  - soliciting for others to complete your homework questions for you.
  - making your homework or homework solutions available publicly
- Homework is not intended to be a grade-maker, but to help you learn the course content. Ultimately, your grade will matter little if you are unable to demonstrate proficient knowledge of course content on the job. Cheating on the homework is not only unethical, but shows a fundamental misunderstanding of the purpose of homework.
- Penalties -- If I become aware of any violations of these rules by a student I will initiate the actions described in the Policy on Academic Integrity. Integrity violations may result in a zero for the assignment, a zero for that portion of your grade, an "F" in the course, among others.