Welcome to Computer Architecture! This is a course about the design and organization of computing hardware component – for computer scientists! Topics include the hardware-software interface, the design decisions that influence processor design, how data is stored and used during execution, and so much more! You will learn to use open-software to simulate hardware, and we will use these tools to model real programs all sorts of hardware designs.

Future iterations of this document will include a planned course schedule, but this is omitted for Fall 2025 for flexibility purposes given that this is the first course offering. See the course website for an intended list of modules that we will cover!

Prerequisites   CS105: Computer Systems

Lecture   MWF 10:00-10:50AM (Edmunds 101)

Lab   Wednesday 7-8:15PM (Edmunds 105)

Final Exam Period   Tuesday, December 9. 9am-12pm (location TBD).

Required Materials   There are no required materials for this course. For additional help, the course website will direct you to the relevant sections of *Computer Architecture: A Quantitative Approach* and *Modern Processor Design: Fundamentals for Superscalar Processors* (where there are three copies each in the CS library).

Course Feedback   Feel free to notify me of things that are working, not working, or otherwise about this course before/after class/lab, in office hours, or via the anonymous feedback form. This only works if I follow up and make the appropriate changes, so please hold me accountable if I fail to accommodate.

Course Staff

Instructor   Prof. Sam Thomas (email: samuel.thomas@pomona.edu)

- Monday (2:30-3pm, general; 3-4:30pm CS181CA)

- Tuesday (1:30-2pm, general; 2-3:30pm, CS181CA)

- Wednesday (4:30-5:30pm, general)

- Thursday (9-10am, general).

- Also by appointment (send me an email).

Course Policies

Attendance Policy   Lecture and lab attendance is strongly encouraged. Students may have up to 4 excused absences (informing the instructor 48+ hours in advance) throughout the semester. Failure to meet the attendance policy may result in lower marks in the participation score.

With this in mind, we live in a post COVID-19 world. If you are feeling unwell, please do not come to class and contact the instructor when you are well. You will be directed to the appropriate resources to get back on track.

To ensure your well-being, missing two lectures in a row without communication will result in a direct communication from me to you via email. If you miss a third session in a row without response, I will issue a Low-Grade Notice, which will notify the Dean of Students.

Assignment Submission   All assignments are due at 6:59pm on Wednesday (before lab). If you need an extension, please contact the instructor at least 48 hours before the assignment is due. Expect extensions to be granted for reasons similar to excused absences. Every 48 hours the assignment is late will be a 10% deduction in the overall score.

Note, deadlines are designed for your benefit and the benefit of your peers. Grades are only to be released after all submissions have been made, and failure to meet the deadline prolongs the release of grades for you and your peers.

Collaboration Policy   While assignment submissions are to be done individually, collaboration on assignments is highly encouraged! Check-Ins are to be done in-class and individually.

AI Policy   This policy is adopted from CS62 (Spring 2025) which was produced by students after class discussion and will serve as a starting template for this course. We will refine the policy on the first day of class!

Use of ChatGPT and other LLMs in this course is permitted under limited circumstances. All use of generative AI must be properly cited and documented, i.e., students should indicate in the header of all submitted code the extent to which they used generated code. Students should save session logs and may be asked to provide these sessions in office hours at the instructor's discretion.

LLMs should be treated in the same way that you would treat a course TA. This means the following are allowed:

- Asking to generate a practice problem

- Asking to explain high level concepts

- Including "Do not generate code. Only explain the concepts." in the prompt.

Students may not use LLMs for:

- Solving homework problems by pasting in the instructions

- Debugging their code by pasting in the code directly

- Generating any code for assignments (please include a "Do not generate code" prompt if you are getting assignment help).

- Appropriate response to violation of the AI policy will be determined on a case-by-case basis in a meeting with the instructor.

Statement of Academic Integrity   Please see the Computer Science's Academic Honest Policy.

In-Class Discussion Policy   To be set by students on the first day of class! When we do so, a non-exhaustive list of things to consider when we do this include[1]:

1. Constructing an inclusive environment in which discussion participants are encouraged to take risks;

2. Ensuring discussion participants come to the discussion prepared to be effective participants;

3. Initiating discussion with engaging, relevant topics or challenges;

4. Encouraging active listening;

5. Helping participants digest what they are hearing;

6. Managing and facilitating the flow of the session;

7. Making clear the statements open for further discussion;

8. As needed, help the group reach a satisfactory closure point.

Office Hours Policy   Office hours are a resource for you to use, and are designed to facilitate your learning. Please come to office hours! At the same time, because it is a shared resource, office hours must be equitably distributed. At my discretion, I will set limits on individual feedback in office hours to ensure that other students are able to receive help.

My hours are spread out across time slots throughout the week to accommodate students with different availability. If the scheduled times do not work for you, feel free to schedule an appointment. If a large cohort of students is unavailable for office hours, I will do my best to change my schedule to accommodate.

My office hours are split by course-specific times and general times to increase their frequency and utility. General times are designed to be times to chat about the course, research, life, or otherwise – so feel free to attend these to discuss course materials or otherwise!

Policies Policy   These policies are designed to help facilitate your learning, but no policy is set in stone. Accommodations can be made on a case-by-case basis where appropriate. Please contact me with any concerns. I am happy to try to help however possible!

---

[1] Adopted from The Sheridan Center at Brown University.

CS181CA Fall 2025

Diversity and Inclusion Statement

Materials in this class are largely derived from materials and innovations from a time period in which a small subset of privileged voices wrote the materials for and heavily influenced the discussion of topics in this course. I acknowledge that the materials that influenced the design of this course have been largely put together by white men. I also want to acknowledge the possibility of overt and covert biases in the materials due to the lens with which it was written. I will also do my best to highlight the contributions of historically underrepresented groups in computing throughout the term in an effort to demonstrate the richness and importance of integrating a diverse set of experiences towards a comprehensive understanding of an area.

The promise of science at its best is that the strength of your contribution does not depend on your identity. While this promise has never been truly fulfilled, part of my job as an instructor aspires to bridge this gap. If you find yourself wondering whether the ways in which you are different from your peers or from the historical figures of academic canon makes you less qualified to be a student or scientist, please remember: the only thing I care about in this class is what you can do, and I promise to work with you to make sure you have what you need to be able to do it. Our field needs more people like and unlike you to show what they can do.

I would like to create a learning environment for my students that supports a diversity of thoughts, perspectives and experiences, and honors your identities (including race, gender, class, sexuality, religion, ability, etc.). To help accomplish this:

- If you have a name and/or set of pronouns that differ from those that appear on your official registration, please let me know!

- If you feel as though your performance in class is impacted by your experiences outside of class, please don't hesitate to come talk to me. I want to be a resource for you. Remember, you can submit anonymous feedback to vocalize your concerns. If you prefer to speak with someone outside of the course, Dean April Mayes is an excellent resource!

- I am always in the process of learning about diverse perspectives and identities. If something was said in class (by anyone, myself included) that made you feel uncomfortable, please talk to me about it (again, anonymous feedback is an option).

If you feel empowered already, I hope you will join me in taking responsibility to empower your peers.

This statement was largely influenced by the "Sample syllabus statements" from the Sheridan Teaching Center at Brown University.

CS181CA Fall 2025

Grading

- Assignments: 40%

- Check-Ins: 50%

- Participation: 10%

Assignments There are four assignments throughout this course. Assignments are scheduled to take 2-3 weeks, and points are evenly split across written and programming components. For more on what you can expect from assignments in this course, be sure to look at the assignments page on the course website.

Check-Ins There will be 8 Check-Ins through the term (subject to change). Each non-final exam Check-In will introduce 2-4 new questions, and you will be provided adequate time to complete each Check-In during the scheduled class time. Please contact the instructor as soon as possible if you require special accommodations. If you are permitted accommodations, please take them!

Check-Ins are in-class pen-and-paper exams graded using the "Standards Grading" methodology. The aim of this evaluation is to encourage students to demonstrate nuanced proficiency over the materials that we will cover in class without being overly punitive. If you do not receive the top mark on a question in a Check-In, a similar question in the same topic will appear on your next exam. Once you receive top mark, you have demonstrated proficiency over that standard and will no longer be asked about it.

Each question is graded on a scale from 0-2. A score of 0 indicates an incorrect response, and will not receive further feedback. A score of 1 implies the response is close, but is not satisfactory. If you receive a 1, your feedback will indicate why your answer was not a fully satisfactory response. A score indicates a fully satisfactory response.

The final exam for this course will serve as a final Check-In without any new questions. This way, you have an opportunity to see all topics at least twice. Your overall Check-In score will then be computed as your cumulative score across the term.

Tenative Course Schedule

Table 1: Subject to change!

Lecture	Date	Theme	Topic	Reading	Assignment
1	Aug 25	*Introducing Computer Architecture*	What is computer architecture?	Syllabus	
2	Aug 27		The HW/SW Interface	H&P 1.3, 1.9	
3	Aug 29		Data Representations & Assembly	H&P A.1, A.2	
4	Sept 3		Assembly Cont.	S&L 1.2	
Lab 1			Source to Assembly		
5	Sept 5		Instruction Decoding		*Check-In 1 in class*
6	Sept 8	**Last day to add course.**	RISC v CISC	H&P A.4, A.7	
7	Sept 10	*Basic Processor Design*	Hardware Principles	H&P 1.7, S&L 1.3	HW1 released
Lab 2	Sept 10		HW1 starter/setup		
8	Sept 12		Building a Basic CPU (part 1)	TBD	
9	Sept 15		Building a Basic CPU (part 2)	TBD	
10	Sept 17		Pipelining	TBD	
Lab 3	Sept 17		Pipelining Lab	TBD	
11	Sept 19		Building a Pipelined CPU	TBD	*Check-In 2 in class*
12	Sept 22		Pipelined CPU (part 2)	TBD	
13	Sept 24		Pipeline Pitfalls & Hazards	TBD	
Lab 4	Sept 24		Exploring pipelines in gem5	TBD	
14	Sept 26		Managing Hazards	TBD	
15	Sept 29		Introducing Processor Control	TBD	
16	Oct 1	*Memory Hierarchy*	Memory Hierarchy Overview	TBD	**HW1 Due**, HW2 released
Lab 5	Oct 1		HW2 starter/setup	TBD	
17	Oct 3		Reintroducing Caches & Locality	TBD	*Check-In 3 in class*
18	Oct 6		Associativity Revisited	TBD	
19	Oct 8		Associativity Trade-Offs	TBD	
Lab 6	Oct 8		Cache Performance in gem5	TBD	
20	Oct 10		Introducing Cache Coherence	TBD	

CS181CA Fall 2025

Table 1: Subject to change! (Continued)

Lecture	Date	Theme	Topic	Reading	Assignment
	Oct 13		*Fall Break – no class!*		
21	Oct 15	**Tomorrow last day to drop course.**	Cache Coherence, cont.	TBD	**HW2 due**, HW3 released
Lab 7	Oct 15		HW3 starter/setup	TBD	
22	Oct 17		Shared Caches and Cache Security	TBD	*Check-In 4 in class*
23	Oct 20		Cache Security cont. and Mitigations	TBD	
24	Oct 22	*Processor Optimizations*	Pipeline Revisited and Control Hazards	TBD	
Lab 8	Oct 22		Cache Attack Lab	TBD	
25	Oct 24		Managing the PC	TBD	
26	Oct 27		Motivating Branch Prediction	TBD	
27	Oct 29		Building a Branch Predictor	TBD	**HW3 due**, HW4 released
Lab 9	Oct 29		Branch Prediction Lab	TBD	
28	Oct 31		Introducing Transient Execution	TBD	*Check-In 5 in class*
29	Nov 3		Implementing Speculation	TBD	
30	Nov 5		Implementing Speculation cont.	TBD	
Lab 10	Nov 5		Exploiting Speculation	TBD	
31	Nov 7		Mitigating Speculative Execution	TBD	*Check-In 6 in class*
32	Nov 10	*Thread- and Data-Level Parallelism*	Multiprocessor Architectures	TBD	
33	Nov 12		GPU Overview	TBD	
Lab 12	Nov 12		Parallel Computing Lab	TBD	
34	Nov 14		**No class!**	TBD	Colloquium reflection
35	Nov 17	*Advanced Metrics*	Market Forces	TBD	
36	Nov 19		Power and Energy	TBD	**HW4 due**
Lab 13	Nov 19		Carbon Explorer	TBD	**Submit lab.**
37	Nov 21		Green Computer Architectures	TBD	*Check-In 7 in class*

Continued on next page

Table 1: Subject to change! (Continued)

Lecture	Date	Theme	Topic	Reading	Assignment
38	Nov 24	(non-evaluative, Happy Thanksgiving!)	Carbon, cont.	TBD	
39	Dec 1		Modern Issues & Emerging Architectures	TBD	*Check-In 8 in class*
40	Dec 3		Potpourri from recent conferences	TBD	

　　　　　　　　　　　CS181CA Fall 2025

External Resources

Quantitative Skills Center (QSC)   The Quantitative Skills Center (QSC) provides academic support to Pomona College students in courses that feature a large degree of quantitative and/or scientific reasoning through our QSC Partners Program. QSC partners meet one-on-one with students to provide support for a variety of Pomona courses for course specific help. The QSC also offers non-course specific help in general quantitative skills and offers consultations for projects and theses involving quantitative methods. Additionally, Dylan Worcester, Director of the QSC, and Angel Bradley, Assistant Director of the QSC are available to meet with you regarding your success in STEM at Pomona College. To make an appointment at the QSC, please visit `pomona.mywconline.com` or contact us at qsc@pomona.edu. The QSC is located in SCC (Smith Campus Center) 228.

Accessibility Resources and Services (ARS)   Pomona College is committed to the fair and equitable treatment of all members of our community. This includes providing and improving accessibility for everyone at Pomona College. Consistent with the open community of Pomona, this includes people with specific needs or disabilities. We encourage you to have a conversation with your instructors, coaches, mentors, and others on campus who can help you access what you need to succeed. See this link for a nonexhaustive list of accommodations. For specific academic accommodations, students need to submit documentation with the ARS office and engage in an interactive process to determine which accommodation(s) may be appropriate. For more information, please reach out to disability@pomona.edu. See this step-by-step guide to the accommodations process and ways that you can be supported. Additionally, students can receive assistance and resources from the 7C Student Disability Resource Center (SDRC). The SDRC hosts events, loans assistive technology, and offers student accommodation support.

Mental Health and Wellness Resources   Monsour Counseling and Psychological Services (MCAPS) is the mental health resource to the five undergraduate institutions of The Claremont Colleges. Their professional staff serves all enrolled undergraduates and provides in-person counseling. There are no fees for counseling services and all services are confidential. In addition, 7C Health (TimelyMD) provides 24/7 access to on-demand medical care and "Talk Now" mental health support, along with links to short videos that support mental and physical wellbeing. The Student Assistance Program (SAP) is a free service available through Aetna for students. The SAP allows students to engage with a clinician for three, free sessions. Phone: 909-607-2000. MCAPS Crisis Line: 909-621-8202; Dial "1". The Wellness Resources page contains additional information about mental, physical, and other student support services.

Religious & Spiritual Life   At The Claremont Colleges, the Chaplains serve as confidential spiritual counselors, emotional leaders, and provide ethical leadership to the campus community at large. There are four Chaplains onsite, a Protestant Pastor, Rabbi, Imam and Catholic Priest. Though each Chaplain holds a specific faith, they encourage and support all religious and spiritual student groups and communities on campus. It is the goal of the Chaplains to strengthen individual faith and promote interfaith relations. The Chaplains offer religious support, engagement opportunities, and create a faith community for students as they pursue their education. The McAlister Center, a shared site for 7C religious activities, is located at 919 N. Columbia Ave. The Center includes a Prayer and Medication Room, Lounge, Library, Community Room, Kosher Kitchen, and outdoor patio. You can sign up for their mailing list and reserve spaces through the website. For further advice and to speak with a religious leader, please reach out

to the chaplains' office at chaplains@claremont.edu. For a list of major religious holy days for 2024-25, see the bottom of the Chaplain's information page.

Peer Mentoring Programs   At the 7Cs we have a range of resource centers and student groups that offer peer mentoring programs and opportunities for social connection to Pomona College students. See below for a partial list of these programs and support systems. Interested students can visit Engage for a full list of current student organizations and how to get involved.

- Asian American Resource Center (AARC), serves Asian Pacific Islander Desi American (APIDA) students

- Chicano/Latino Student Affairs (CLSA), provides services to Chicanx/Latinx students in the 7Cs

- Draper Center for Community Partnerships, fosters collaborations between the campus and the community

- DACA/Undocumented Student Resources, provides support to DACAmented and undocumented students

- The Empower Center, 7C violence prevention and advocacy program

- First Generation and/or low-income (FLI) Scholars, provides support for FLI students at Pomona

- International Student Services, office providing support to international students

- Mellon Mays Undergraduate Fellowship Program (MMUF), 5C program for junior and senior humanists

- Native American Initiatives Office, serves the needs of Native & Indigenous students

- Office of Black Students Affairs (OBSA), 7C support, resources, and space for students of African decent

- International & Domestic Programs, offers support to students interested in off-campus study

- Queer Resource Center (QRC), 7C resource for LGBTQQ+ students and their allies

- Women's Union, provides space and programming tailored to the diverse needs of women at the 7Cs

Health and Safety Telephone Numbers

Campus Safety	909-607-2000	
Administrator On Call	909-607-2000	(On-campus administrator available to respond to emergent student concerns at all hours)
Student Health Services	909-621-8222	
After Hours Emergency	909-607-2000	
National Suicide & Crisis Lifeline	988	
Project Sister Family Services	800-656-4357	(24/7 Sexual Assault Crisis Hotline)