

UNIVERSITY OF CALIFORNIA
Department of Electrical Engineering
and Computer Sciences
Computer Science Division

CS 61C
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CS 61C: Machine Structures
General Course Information
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Introduction

The CS 61 series is an introduction to computer science, with particular emphasis on software and on machines from a programmer’s point of view. The first two courses considered programming at a high level of abstraction, introducing a range of programming paradigms and common techniques. This course, the last in the series, concentrates on machines and how they carry out the programs you write.

In CS 61C, we are concerned not so much with the process of writing a computer program, but rather with how the computer carries out a program. That is, the main topic in this course is the structure of a “logical machine”—not the actual electronic circuits, but the computational operations that those circuits carry out. To make these ideas concrete, you will study in some detail the machine language of a particular computer, the MIPS R2000 processor. In real life, you might never actually write a program in machine language, but for us it serves as a vehicle for teaching about computer architecture.

Instructors

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Office hours are primarily for short questions and administrative problems. We are happy to make appointments for longer periods of time if you feel you need it. Please don’t be shy; We would rather see you as soon as you don’t understand something than right before the exam. It’s not an imposition—we *like* teaching. Please don’t ask us about individual *administrative* problems in lecture; We have to be in our office to have access to our files.

Do You Belong Here?

CS 61B is a prerequisite for CS 61C, but can be waived if you have prior programming experience in the C, C++, or Java language. (For example, if you studied Pascal elsewhere, you could take the one-unit self-paced CS 9C.) For our purposes in this course, C, C++, and Java are equivalent, because our emphasis here is on low-level operations.

Course Materials

We will be using the second edition of Patterson and Hennessy's *Computer Organization and Design* book ("COD"). Try to find the third printing. We won't use the entire book, which goes into a lot of detail about hardware organization beyond the scope of 61C. The same text will also be useful to you in a later architecture course (CS 152). (Don't get *Computer Architecture: A Quantitative Approach* by the same authors; it is intended for a graduate course!).

We are also requiring *The C Programming Language* (second edition) by Kernighan and Ritchie ("K&R").

In addition, there will be a course reader, containing the homework assignments for the semester, three previous semester's exams, and a few additional handouts. Course materials will also be posted on the class website: <http://www-inst.eecs.berkeley.edu/~cs61c/>. Also, If you are not familiar with the Unix operating system, you are advised to purchase the *EECS Instructional User's Guide to Unix*. These readers are sold at Copy Central on Euclid, half a block north of the North Gate entrance to campus, or on Bancroft, across the street from the southern edge of campus.

Enrollment—Laboratory and Discussion Sections

In addition to the lectures Monday and Wednesday, the course consists of a one hour discussion section and a two hour lab section per week, along with some additional unscheduled lab time. If you are pre-enrolled, you have been scheduled a lab section that meets in 271 Soda and a discussion section in a classroom. The discussion/lab sections are run by student Teaching Assistants; each TA will handle enrollment for his or her sections. We anticipate some rearrangements during the second week in response to oversubscribed or undersubscribed sections. If you are not pre-enrolled, you should pick a discussion/lab section, but be prepared to shift if your first choice is full. Please try to be in a definite discussion/lab section by the second week.

You must have a computer account on the 61C course facility. You must set up your account *this week* because that is how we know who is really in the class. Account forms will be distributed at the first lecture, along with this handout. If you missed the first lecture, see Sue DeVries or Cindy Palwick in 385 Soda to get your account. The first time you log in, you will be asked to type in your name and reg card number, if you have one. Please follow the instructions carefully. You must get your account *and log into it* no later than **4pm Friday** so that we have an accurate class count.

Some of you have personal computers and may want to do the course work at home. This will be possible for some assignments but probably not for others, because of special software you'll need (although of course you can connect to the lab computer from home). In any case, though, you must get a class account even if you intend never to use it.

Please do not sign up for a computer science course just to get a computer account, with the intention of dropping later. (Instead, come see a faculty member to discuss sponsorship of a non-class account for independent study, or you can get a free Unix account from the Open Computing Facility, www.ocf.berkeley.edu.) Accounts of students who are not doing the course work will be turned off by the third week of classes. Also, if you

get a class account and then decide to drop the course, please let us know *immediately* so that we can admit another student. Thank you.

If you are not pre-enrolled and want to take 61C, you have to add the course using Tele-BEARS. If you are something other than a regular Berkeley undergraduate, then you probably need a signature on a form admitting you to the course. Our past experience indicates that enough pre-enrolled students will drop the course to allow us to admit all qualified applicants. However, we won't be sure about this until after everyone has picked up class accounts. Therefore, we will not sign your add form until the *second* week of classes. We'll give you instructions about that procedure later. Meanwhile, you should get your computer account and begin doing the course work on the assumption that you will be admitted.

Students sometimes ask whether section attendance is required or optional. Our expectation is that you will attend all class sessions, but you are adults and we are not going to police your attendance. However, sections may discuss some details not covered in lecture, and there will be specific assigned work in the lab sections. The discussion and lab sections are also your best opportunity to ask questions and learn interactively. Finally, it is in your interest for your TA to know who you are.

Human Resources

The instructors and the Teaching Assistants who teach the discussion/lab sections are also available to answer questions. You may drop in during office hours, make appointments for other times, or communicate with us by electronic mail.

For technical questions about the homework or about the computer facility, or administrative questions such as missing homework grades, send electronic mail to your particular TA or reader. You can also send mail to the instructors about technical questions, but if it's about grades we'll just refer you to your TA.

There is an electronic bulletin board system that you can use to communicate with other 61C students. To do this, subscribe to the `ucb.class.cs61c` newsgroup by saying

`rn ucb.class.cs61c`

Please do not send electronic mail to every student individually! That would waste a lot of disk space, even for a small message. Use the newsgroup instead. Electronic mail is for messages to individuals, not to groups.

Tutoring services are provided by Eta Kappa Nu (HKN), the EECS honors society, at 2-7346 or e-mail to `hkn@hkn`. They have an office in 345 Soda.

Computer Resources

The computing laboratory in 271 Soda consists of SunRay terminals connected to a server named `nova.cs.berkeley.edu`.

The lab in 271 Soda is normally open until 6:30pm, but you can get in after that with a cardkey. These will be available in a week or so after the class membership settles down.

If there are no free workstations, please feel free to ask anyone who is not doing course work to leave. In particular, *game playing is not permitted* because of damage to the mice. We are relying on social pressure to discourage abuse (such as stealing the chairs or

monopolizing a workstation for six hours during prime time to play chess). Therefore, do not feel embarrassed to apply such pressure.

If you have a home computer, you may wish to use your class account remotely. You're on your own for whatever connectivity software your computer requires.

Computer Community Spirit

If you live in a dorm or other concentrated student housing, you have already learned that any facility shared by a large group of people is fertile ground for practical jokes. You've also learned that selfishness in the use of common facilities can lead to a lot of bad feeling. Computers are no different. For example, there is only a finite amount of file storage space. If you fill it up with digitized pictures of all your friends, other people can't get their homework done.

In the dorm, people generally have a good sense of perspective about what's funny and what isn't. Filling up your friend's room across the hall with balloons is funny. Filling it up with water balloons is on the edge. Filling it up with epoxy isn't funny at all. But for some reason, some people seem to lose that sense of perspective when it comes to computers. Perhaps it's because the damaged property is intangible; perhaps it's because with a computer you don't have to be physically near the victim. Whatever the reason, try to overcome it. It may be funny if your friend sees an unexpected message when s/he logs in, but it's not funny if s/he can't complete the assigned course work because of deleted files.

The operating system we use provides enough security so that nothing you do will mess up another user by accident if you're minding your own business. It is certainly possible to mess up the system deliberately. Many of you are familiar with the personal computer environment, in which some people consider it a mark of sophistication to write "virus" programs that interfere with other people's computers. You are now entering a different culture, with different values. Our computer facility is part of the Internet, a worldwide network with hundreds of thousands of computers at universities and other research, government, and commercial organizations. The network is deliberately set up to *encourage* collaboration among its users, and that means encouraging easy access to one another's systems. This policy requires some degree of trust among the participants. If you've ever taken anything out of a safe deposit box at a bank, you know that it's possible to design a high-security shared facility, but that the cost is making it a big pain in the neck to use the secured data. Some computer systems are designed to have bank-level security, and everyone will think you're very clever if you figure out how to mess up such a system. Nobody will think you're clever if you mess up the 61C system.

The form you sign when you get your computer account says that it is for your use only, and for course work only. We are not unreasonably strict in enforcing this rule. Nobody minds if you occasionally play a computer game late at night, if it's the kind that doesn't wreck the keyboards or mice through repeated high-speed banging on one button. Nobody will object even if you occasionally bring a friend to play the game with you, or if you write an occasional English paper on this facility instead of the official English Department computers. But if you are asked to give up the terminal by someone who wants to do course work and refuse, or if you get on the weekly list of "disk hogs" and

we find six other people's files in your directory, that's unacceptable. Remember, you and your fellow students are the ones who suffer from such selfishness; the faculty and staff have other computers to work on.

Network Etiquette

Our computer facility is part of a worldwide network that lets you communicate with other users both by electronic mail and by immediate connection if you're both logged on at the same time. You will find that this network, much like amateur radio, is a good way to make friends.

However, please remember that the network is *not* exactly like amateur radio, in that most of the people using the net are trying to get work done and don't want to spend time talking with you. Therefore, please do not send mail or talk requests to people whom you don't know. For example, if your best friend from home went to college somewhere else and you don't know his or her e-mail address, do not ask randomly chosen people at that college to locate your friend for you. (You can send mail to **postmaster** at most sites.)

In particular, please keep in mind that many female users of the network regard unsolicited communication from unknown male users as a form of sexual harassment. (Research has shown that users with obviously female login names do get more than their share of such unsolicited mail.) Even if your intent is not to harass, bear in mind how your communication might be interpreted by the recipient.

The way to get to know people on the net is to join newsgroups. The same program that you use for the class newsgroup will also let you subscribe to groups on an enormous range of topics, both technical and recreational. Most participants in these groups will welcome individual communication that's relevant to the newsgroup topic.

Here are a few rules of newsgroup etiquette: (1) Do not post to a group until you've read it for a couple of weeks, so you'll know what people consider appropriate topics for that group. (2) Do not post messages in which you quote all of someone else's long message and then add "Me too!" at the bottom. (3) Don't be sarcastic. If you're angry, wait until tomorrow to post your message. Remember, too, that the other person isn't necessarily just like you; he or she may be eight years old, or eighty. (4) **Do not** post or mail chain letters! You will certainly lose your Berkeley computer account and may find yourself under arrest for fraud.

It is strongly encouraged that you subscribe to the group **news.announce.newusers** for more information about posting to newsgroups.

Homework and Programming Assignments

Parts of this course are still under development, so there may be some changes in the details that follow, but here's the plan as of now:

There will be 15 homework assignments during the term. (The first week's assignment is attached to this handout.) Each week's assignment will be due Monday of the *following* week at 9am. The purpose of the homework is for you to learn the course material, not to prove that you already know it. Therefore, the weekly homeworks are not graded on performance; you get full credit (one point per week) for any reasonable effort. There will also be six longer assignments, called projects, involving C programming, assembly

language programming, Verilog coding, and CPU and Cache simulation. *The projects are graded for correctness and clarity.* You may do the homework assignments along with the other members of your working group, however, the projects must be done by yourself. All of the assignments and projects for the semester are included in the course reader and will be posted online.

Please complete the *reading* assignment for each week **before** the first lecture. For example, you should read Chapters 5–6 of K&R before the lecture of Wednesday, 9/3. (Monday of that week is a holiday.) Also, read Chapter 1 and sections 4.1 and 4.2 of P&H and Chapters 1–4 of K&R as soon as possible this week! You will have five class meetings (three lectures and two discussion/lab sections) to help you understand each assignment. During that time you should begin to work on the exercises, and you should try to complete them in the lab later in the week. If you're efficient, you'll then have the weekend to read the following week's reading assignment.

Starting next week, you can work on the homework with a group of other students, but *each person must do the projects individually.*

Homework assignments will be due at 9am each Monday. (Our intent is that you finish before Monday, not that you stay up all Sunday night!) All homework assignments (and projects) will be submitted electronically as described in the assignment handouts.

Recording of Lectures

Lectures will be webcast live, recorded and archived. Our preference is that you attend lectures live so that you can interact with the instructors and other students. However, we realize that you will have occasional scheduling conflicts. Also, you might find it useful to view past lectures for review. See webcast.berkeley.edu and follow the links to CS61c for more information on how to connect.

Lost and Found

When people bring us found items from lecture or lab, we take them to the CS office, 387 Soda. Another place to check for lost items is the campus police office in Sproul Hall.

Testing and Grading

The grading policy of the course has these goals: It should encourage you to do the course work and reward reasonable effort with reasonable grades; it should minimize competitiveness and grade pressure, so that you can focus instead on the intellectual content of the course; and it should minimize the time we spend arguing with students about their grades. To meet these goals, your course grade is computed using a point system with a total of 200 points:

15 homeworks	15 * 2	30
6 projects	6 * 10	60
2 midterms	2 * 30	60
final		50
TOTAL		200

The homeworks will be graded two points each for effort. Projects are graded 10 points each on correctness and clarity.

There will be two midterms (during the seventh and twelfth weeks of the semester) and a final. The exams will be open book, open notes. In the past, some students have complained about time pressure, so we'll hold the midterm exams in the evening (at 7pm) instead of during the lecture hour. Our goal will be to write one-hour tests, but you'll have two hours to work on them. In general, tests concentrate on the material that has been covered up to and including the week before the test. In this course, the later topics depend on the early ones, so you mustn't forget things after each test is over!

A score of 180 or more is an A+; 175 is A; 170 is A-; and so on down by steps of 5, to 125 points for a D-. This grading formula implies that **there is no curve**; your grade will depend only on how well you, and not on how well everyone else does. (If everyone does exceptionally badly on some exam, we may decide the exam was at fault rather than the students, in which case we'll adjust the grade cutoffs as we deem appropriate. But we won't adjust in the other direction; if everyone gets an A, that's great.)

If you believe we have misgraded an exam, return it to your TA with a note explaining your complaint. Only if you are unable to reach an agreement with the TA should you bring the test to us. (Of course we want to be fair about correcting actual errors in the grading of your test. But you'll probably find us less sympathetic about pleas for greater partial credit for wrong answers. One implication of our liberal grading policy is that if you're feeling desperately anxious because you're right on the edge between an A- and an A, we'll be thinking that your real understanding of the course is probably closer to a B. In any case, We consider such conversations demeaning to both parties.) By University policy, final exams may *not* be regraded. They may be viewed at times and places to be announced.

Incomplete grades will be granted only for dire medical or personal emergencies that cause you to miss the final, and only if your work up to that point has been satisfactory.

Cheating

Since the textbook exercises are largely the same from one semester to the next in this course, you may be tempted to turn in the official published solutions collected by a friend who's already taken the course. Don't do it. Not only would that be dishonest, but also, *doing the homework is the main way you learn in this course*. Read the published solutions *after* you struggle with each problem yourself. If you find yourself in a position where you are unable to complete the homework, we prefer that rather than copying the solution or turning in someone else's work, that you turn in nothing and take a zero on that assignment.

We hope that you will work cooperatively with your friends *before* the exams to help each other prepare by learning the ideas and skills in the course, however during the test you're on your own. The EECS Department Policy on Academic Dishonesty says, "Copying all or part of another person's work, or using reference materials not specifically allowed, are forms of cheating and will not be tolerated." (61C tests are open-book, so reference materials are okay.)

In our experience, nobody begins the semester with the intention of cheating. Students

who cheat do so because they fall behind gradually, and then panic at the last minute. Some students get into this situation because they are afraid of an unpleasant conversation with an instructor if they admit to not understanding something. We would much rather deal with your misunderstanding *early* than deal with its consequences later. Even if the problem is that you spent the weekend in a drunken orgy instead of doing your homework, please overcome your guilt feelings and ask for help as soon as you need it.

Because you will be submitting all your work (except for exams) electronically, it is easy for us to run software that checks your solutions to those of other students and other semesters. The software we use is fairly sophisticated in its ability to catch copying. For instance, simply changing variable names in a program will still get caught. In fact, usually the effort that you must take to fool the checking software would be more than just completing the assignment in the first place.

If we find that you have cheated on a homework assignment, you will receive a -4 on that assignment. If we catch you cheating on an exam or project you will receive a zero, or depending on the circumstances, an F in the course. For repeated instances of cheating we will refer you to the Office of Student Judicial Affairs.

Lateness

A project that is not turned in by the deadline may be turned in, electronically as usual, until Tuesday 9am. These late projects will count for $2/3$ of the earned score. No credit will be given for late homeworks, or for projects turned in after Tuesday. Please do not beg and plead for exceptions. If some personal crisis disrupts your schedule one week, don't waste your time and ours by trying to fake it; just be sure you do the next week's work on time.

By the way, if you wait until the last day to do the project, you will probably experience both a shortage of available workstations and unusually slow computer response.

Questions and Answers

Q: I am pre-enrolled for this course, and I'm planning to do the homework on my home computer. Do I still have to pick up a class account and log in by Friday to stay in the class?

A: Yes.

Q: I am a transfer student, and I'm pressed for time to fit in all my graduation requirements. I know how to program in assembler. Do I really have to take 61C?

A: Probably. 61C covers many topics not currently covered in Community College. However, if you took a similar course at a four year university, you have have covered the correct set of topics. Mike Clancy, in 779 Soda, is in charge of approving substitution of courses taken elsewhere.

Q: I'm not pre-enrolled. How do I know which discussion/lab section to attend?

A: For now, just pick any one. If the one you pick is too crowded, the TA may ask some people to move. With luck, things will settle down reasonably in a week or so.

Q: I need my extension form signed this week in order to satisfy my employer, or my school, or somebody. Can't you let me in early?

A: We're sorry, but we have to get an accurate class count first. Most of the time enough pre-enrolled people drop (or just don't show up) in the first week to allow us to let everyone in, but we are not permitted to accept extension students (except through the Reentry Program) until all regularly enrolled undergraduates are in.

Q: What's your advice on surviving this course?

A: Two things: Do the reading and assignments early, and ask for help as soon as you don't understand something.

Q: I got the Nobel prize last year, and my uncle is Chancellor of Berkeley. Do I still have to use my class account by Friday to stay in the class?

A: Yes.

Q: I am disabled and need special facilities or arrangements to do the course work. What should I do about it?

A: If you need special arrangements about class attendance, taking tests, etc., we will be glad to accommodate you; please take the initiative about letting us know what you need. For example, if you want to take tests separately, that's fine, as long as you ensure that we've worked out the arrangements before the test. The Disabled Students Program (ext. 2-0518) has voice response terminals from which blind students can connect to our computers. **If English is not your native language**, and you have trouble understanding the course materials or lectures for that reason, please ask for help about that too.

Q: I don't like (or have a conflict with) my pre-assigned discussion/lab section. Can I switch?

A: You must negotiate this with the TA of the section you want to switch into. Please try to be settled into a definite section by next week, when the group assignments will be made. There's no need to update your TeleBears record, as long as both your old and your new TAs agree.

Q: Can I form a group with students in other sections?

A: Generally not. One purpose of the scheduled lab meetings is to ensure that your entire group can spend some time working together with your TA available to help. If you want to be in the same group with a friend, arrange your schedules so that you can be in the same section. If there's some special reason why you think you should be an exception, negotiate with the TA or TAs involved.

Q: I'm not pre-enrolled, so I don't have an official discussion/lab section yet. Under which section should I turn in the first week's homework assignment?

A: Whichever section you attended during the first week. Once you have an official section, you should turn homework in under that one.

Q: What should we call you?

A: Brian Harvey: If you're being formal, or don't like the course, "Dr. Harvey." Otherwise, "Brian."

A: John Wawrzynek: If you would like to be formal, "Professor" is fine (as most people don't remember how to pronounce my last name.). "John" is perfectly ok with me.

Lecture Outline and Reading Assignments

In the following chart, the readings refer to chapters in the Patterson and Hennessey (P&H) or Kernighan and Ritchie (K&R) text. Remember, the reading should be done *before* the week indicated. A more detailed version of this chart is available on the class website under "calendar".

week	Monday	topic [project]	Wednesday	Friday	reading
1	8/25	intro, numerals, C	8/27	8/29	P&H 1, 4.1, 4.2; K&R 1-4
2		holiday (M) , C	9/3	9/5	K&R 5,6
3	9/8	C	9/10	9/12	K&R 7,8
4	9/15	malloc (M), MIPS (WF) [LISP]	9/17	9/19	P&H 3
5	9/22	MIPS	9/24	9/26	P&H 4.1-7
6	9/29	floats (MW), performance (F) [sprintf]	10/1	10/3	P&H 4.8-13, 2
		Midterm Tuesday, 10/7, 7-9pm			
7	10/6	compilation (MW), disk (F)	10/8	10/10	P&H A.1-6
8	10/13	input/output [CPU simulator]	10/15	10/17	P&H 8
9	10/20	I/O (M), networks (WF)	10/22	10/24	
10	10/27	cache [interrupts]	10/29	10/31	P&H 7.1-3
11	11/3	virtual memory (MW), CPU (F)	11/5	11/7	P&H 7.4-10
		Midterm Thursday, 11/13, 7-9pm			
12	11/10	CPU (MW), Verilog (F) [cache]	11/12	11/14	
13	11/17	Verilog (MW), pipeline (F)	11/19	11/21	P&H 6
14	11/24	logic, holiday (F) [Verilog]	11/26		P&H B
15	12/1	advanced topics	12/3	12/5	P&H 9 (optional)
		Final Wednesday, 12/10, 8-11am			