

## Course Information

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### Course Overview

Are there “laws of physics” in computing? Are there fundamental restrictions to what computers can and cannot do? If so, what do these restrictions look like? What would make one problem intrinsically harder to solve than another? And what would such restrictions mean for our ability to solve meaningful problems with computing power?

In CS103, we'll explore the answers to these important questions. We'll begin with an introduction to mathematical proofs and discrete structures, which will enable us to model the sorts of systems that arise in computer science. In the course of doing so, we'll explore mathematical logic, linked structures, and the mathematical nature of infinity.

We'll continue by exploring finite automata (mathematical models of computers with finite memory) and from there will explore context-free grammars and Turing machines (mathematical models of computers with unbounded memory). As we explore these models, we'll see their strengths and their weaknesses and will explore questions like “what does it mean to solve a problem?” and “why does this problem seem to resist a solution?” Finally, we'll conclude with a quick introduction to complexity theory and explore what we know – and what we don't – about efficient computation.

In the course of the quarter, you'll see some of the most impressive (and intellectually beautiful) mathematical results of the last 150 years. You'll see what proof-based mathematics is all about and will gain more confidence using mathematics to model and solve problems. You'll learn about various discrete structures that arise throughout computer science. You'll learn how to think about computation itself and how to show that certain problems are impossible to solve. Finally, you'll get a sense of what lies on the frontier of computer science, especially with regards to the  $\mathbf{P} \stackrel{?}{=} \mathbf{NP}$  problem.

### Instructor

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### TAs

Luna Frank-Fischer ([luna16@stanford.edu](mailto:luna16@stanford.edu)) (*Head TA*)

Anna Saplitski  
Bill McDowell  
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Jade Huang  
Juhi Naik  
Karen Wang  
Kevin Gibbons  
Kunmi Jeje  
Michela Meister  
Rahul Palamuttam  
Richard Tang  
Sarah K  
Shloka Desai

### Website

The course website is [cs103.stanford.edu](http://cs103.stanford.edu) and it's loaded with resources for this course. There, you'll find all the handouts for this course, lecture slides, and additional links that you may find useful. I would suggest periodically polling the website to stay on top of any important developments in the course.

- Email** The course staff can be reached at [cs103-aut1617-staff@lists.stanford.edu](mailto:cs103-aut1617-staff@lists.stanford.edu). Please don't hesitate to send us emails! We're here because we genuinely love this material and want to share it with you. If you have any questions on the material, or if you're interested in exploring more advanced content, please get in touch with us. We'd be happy to help out.
- Piazza** We have a class Piazza forum you can use to ask questions about the material and to get help and advice on the problem sets and discussion problems. Our policies regarding Piazza use will be covered in an upcoming handout on problem set policies.
- Lectures** Mondays, Wednesdays, and Fridays, 3:00 – 4:20 in Nvidia Auditorium. Lecture videos will be recorded and made available on the SCPD website.
- Based on the advice from past CS103 students – and from our own experiences – if you are an on-campus Stanford student, we *strongly recommend* attending all lectures in person if possible.
- Units** If you are an undergraduate or are enrolled in this course through SCPD, you need to take CS103 for five units (this is department policy). If you are a graduate student, you may enroll for anywhere between three and five units, depending on what best fits into your schedule. Regardless of how many units you are enrolled for, the course content and requirements will be the same. The unit flexibility is simply to make life easier for graduate students.
- Five-unit courses at Stanford vary greatly in their difficulty. Based on past student experiences, you should expect that this course probably will require a time investment proportional to its unit load. Expect to put in a total of at least 15 hours each week – including lecture time – working on CS103. We'll offer a lot of support through office hours, extra practice problems, and practice exams, so if you're willing to put in the effort to learn the material, the course staff will be behind you every step of the way.
- Prerequisites** Although CS103 is a course on the mathematical theory behind computer science, the only actual math we'll need as prerequisites is high-school algebra. We'll build up all the remaining mathematical machinery we need as we go. We've released another handout detailing the mathematical prerequisites for this course, so if you have any questions, check it out and see what you find!
- If you're interested in taking this course but feel that you might not have a sufficient mathematical background, you may want to check out our new add-on course, CS103A, which is discussed later in this handout.
- CS103 has CS106A formally listed as a prerequisite because we want you to have at least a basic familiarity with computer programming before taking the course. Many of the results we'll explore will be intimately connected to computers, computing, and programming, and we'll often use programming metaphors to help guide your understanding. There will only be a small amount of programming in this course, primarily localized around the final topics. As a result, if you have any programming background at all, you're probably in the right place! If you have never programmed before, I suggest dropping by office hours so that we can chat about whether CS103 is a good fit for you.
- Office Hours** The TAs and I will be holding *lots* of office hours during the week so that you can stop by and ask questions about the material. We will also hold dedicated online office hours for SCPD students. We find that many students visit office hours on a somewhat regular basis and encourage you to stop by if you need any help. We'll post a schedule later this week.

**CS103A**

CS103A is an optional, one-unit add-on course for CS103. CS103A meets once a week for two hours and offers extra review and practice problems related to the current course content. If you're interested in taking CS103 but feel like you might need a little bit of extra practice and review, I'd strongly recommend checking out CS103A. The course has limited enrollment this quarter (we're restricted by the amount of space in our classroom), so we'd highly recommend signing up as soon as you can.

**Readings**

There are online course notes for the first few weeks of material. They go into a *lot* more depth than what we're going to end up covering in CS103, but hopefully you'll find them useful for getting a deeper understanding of the material. The course notes are still a work in progress, so please feel free to contact us with corrections of all sorts – logic errors, grammatical issues, formatting problems, etc. We also will release a bunch of handouts over the quarter to provide additional supplementary reading material.

We *recommend* that you pick up a copy of *Introduction to the Theory of Computation, Third Edition* by Michael Sipser. You might find this book useful in the second half of the quarter. Some of the readings in the syllabus are taken from this book, but we will not directly test you on any material in Sipser that is not covered as well in lecture or the problem sets. Although the readings are taken from the third edition of Sipser, you should be able to use the second edition as well. There are several copies of the Sipser textbook on reserve in the engineering library.

**Problem Sets**

There will be nine total problem sets in CS103 given out about once per week. You are welcome to work on them individually or in groups of up to three people. Our full policies with regards to problem sets (late policy, regrades, etc.) will be given in a separate handout later this week.

**Exams**

In addition to problem sets, there will be a two midterm exams and a final exam. The first midterm exam will be held on Monday, October 24 from and the second on Monday, November 14. These exams will be held during the normal class time slot (3:00PM – 4:20PM), but (for space reasons) might not be held in the regular location. We'll announce exam locations later on. The final exam will be held on Monday, December 12 from 3:30PM – 6:30PM, location TBA. All times listed are Pacific time.

If you are an SCPD student, we will send the exams to your proctor 24 hours before the normal exam start time. You may begin taking the exam any time you'd like in the 24 hours before the stated start time.

In accordance with university policy, with the exception of OAE accommodations, we will not offer any alternate final exam times. If you are unable to take the final exam at the stated time, you will need to take this class in another quarter.

Additionally, with the exception of OAE accommodations, we generally do not offer alternate midterm exam times. You should not enroll in CS103 unless you can make both of the midterm times. Since the exam times are during our normal class time, we do not anticipate that this will be a problem.

**Grading**

Overall, your grade for this course will be determined as follows. The problem sets are collectively worth one-third of your grade. Each midterm is worth one-sixth of your grade. The final exam is worth the remaining one-third of your grade.

We do *not* curve grades on individual assignments or exams. Rather, we use raw point totals weighted by the amounts given above to compute everyone's raw total score, then curve raw total scores. Historically, we use the median raw score as the B/B+ cutoff.

Unlike some other courses, we do not drop the lowest problem set or midterm score and do not offer any make-up work. Your raw score will be computed purely by weighting your raw scores by the above amounts, and we will determine final grades based on those raw scores.

Each problem set will include at least one extra credit problem that you're welcome to work on if you'd like an extra challenge. When computing final grades, we determine the grading curve before factoring in extra credit points, so not doing the extra credit problems will not put you at a disadvantage. The extra credit points are purely a bonus.

**Honor Code**

We want to foster a collaborative and supportive atmosphere in CS103. We want you to really learn this material – and, ideally, we hope that you'll find it as exciting as we do. This is why, for example, we have so many office hours sections and why we let you (within limits) work in groups on the assignments.

That said, we expect you to abide by the letter and the spirit of the Stanford Honor Code in CS103. We will release a handout detailing our class policies regarding the Honor Code, which among other things discusses our expectations for what is and is not permissible collaboration on the problem sets.

We hope that you will respect the Honor Code, comport yourself with integrity, and work to create a learning environment where everyone feels supported.

**Incomplete Policy**

If you have a serious medical or family emergency and cannot complete the work in this course, you may contact Keith to request an incomplete. Our policy is to reserve incompletes only for emergencies, so we do not grant incomplete grades for poor performance on the assignments or exams, nor do we offer incompletes for busy work schedules.

In order to be eligible for an incomplete, you must have completed all of the assignments (except possibly the most-recently-due assignment) and must have a performance that is roughly on par with a B- overall grade.