What's CS22?

Suppose you have 9 identical donuts to distribute among 4 people. You wonder to yourself: How many ways could we distribute these donuts among these 4 people? Each person could end up with all the donuts, none or anywhere in between.

Suppose we tell you the number of ways to distribute the donuts is exactly equal to the number of ways you could pick 3 donuts from a box of 12 donuts. Would you believe us? What would we need to do to convince you it's true?

In this class, you will develop the tools to answer such questions. In particular, this class will introduce you to the world of discrete mathematics and its connections to computer science. Discrete mathematics deals with separate and countable entities (like donuts) rather than continuous entities (as you might have previously seen in a calculus class). If you've never heard of discrete math before, don't worry: **you're in exactly the right place**.

This course assumes no prior experience with discrete mathematics. The math in this class has a very different flavor from math in high school like algebra or trigonometry: it is much less mechanical, much more creative, and much more about understanding.

What Sort of Skills Will I Develop in This Course?

This course will give you two skills.

First, it will teach you discrete mathematics and connections between discrete mathematics and computer science. The covered topics are logic, math foundations, number theory, combinatorics, and probability. We will see connections between these mathematical topics and fields of computer science like algorithms, cryptography and machine learning.

Second, this course will teach you how to read and write good mathematical proofs. What is a good proof? We'll talk about that a lot, but for now, we'll say that a proof is an argument that uses the rules of logic to argue that, assuming some premises are true, a conclusion is also true. Proofs are an extremely flexible and precise way of making very good arguments.

This course is not a traditional computer science course in that you won't be doing a huge amount of programming. However, you will develop some experience with LaTeX, a markup language for writing mathematics—you'll use LaTeXto write up most of your homework assignments. LaTeXis the most common way documents are written in both mathematics and computer science (the missive you are reading now was written in LaTeX).

What Do I Need to Know Going In?

Nothing—just come with an open mind about learning some math! There are many courses at Brown that teach mathematical reasoning, and thus overlap to some degree with this one. None of them are prerequisites for 22 and we do not assume that you've taken any of them. To the contrary, taking 22 is likely to help you with more advanced proof-based courses and, in particular, set you up to effectively apply mathematics in computer science in advanced ways.

Time

Getting the most out of this course will take up a lot of your time. Everyone is different, and we therefore can't tell you exactly how much time you'll end up spending on this course. However, we'll just say this: the critical reviews for this course do not exaggerate. Please keep this in mind as you're planning out your schedule for this semester! Also, if you don't have the time to put in the work this semester, please remember that it's offered *every fall and spring*, and we recommend taking it when you have more time on your hands.

Between lectures, recitations, homework, and studying, expect to spend at least 180 hours over the course of the semester.

Course Components

This course has three main components: (1) lectures to introduce you to the main ideas of the course, (2) opportunities to practice these ideas in the form of homeworks and recitation, and (3) proof reviews and exams to help you and us assess your understanding.

Lectures

Ellis will hold lectures on Mondays, Wednesdays, and Fridays from 11:00AM to 11:50AM in CIT 165. Course-related announcements may be made in class, and, while you are not required to attend, you are responsible for anything covered in lecture. We will release lecture slides, but they are meant to reinforce what you learned in lectures, not replace them. The lectures will be recorded and available on the course website for those who prefer asynchronous attendance; however, we strongly recommend attendance. Another available resource to reinforce the material from lecture is the course textbook, which can be found on our website.

Homework

Homeworks will typically be released on Tuesdays, and are due the following Monday at 6:00pm Eastern Time on Gradescope. You are encouraged to work in groups on the homework. Homeworks will be graded on completion—if you turn in your best attempt you will get full credit. However, you must **independently** write up your own solutions.

Because homeworks are graded on completion, there will be no late days, extensions or regrade requests. If you are not able to turn something in on time but would still like feedback, we encourage you to go to office hours to go over your answers with a TA.

After Homework 2, all submissions must be typed up using **LaTeX**. Starting from Homework 3, **any handwritten or non-LaTeXed submissions will receive no credit**. Resources for learning LaTeX are available on the course website, and we will have a LaTeX gearup session in the first two weeks. Note that you may hand-draw diagrams on your submission.

You are allowed to use whatever generative AI tools you like on the homeworks—including ChatGPT, Claude, etc.—as well as whatever online resources you feel will help your learning. However, we recommend you do not rely too heavily on these tools—learning this material in a deep way requires, to some extent, struggling with it. Likewise, using such tools to get the right answers on the homework will not improve your grade since homeworks are graded on completion. Also keep in mind that you will be asked to present and defend your homework solutions in proof reviews.

We reserve the right to not grade your homework (though you will still receive full credit in these cases) if:

- Your homework looks to be the output of an LLM or;
- Your homework is identical or extremely similar to that of another student.

We will provide you feedback on your homework as if it is graded on correctness so you can learn what you did correctly and incorrectly.

Recitation

Each week, there will be several identical recitation sessions (see the course webpage for times and locations). Recitations are required and are overseen by TAs. You must sign up for a recitation time, but for the first recitation you can attend any recitation you want. At recitation, you will be randomly assigned a group of 4-5 people in your recitation section, be given a packet of problems and then you will work with this group to complete the questions in the packet as a group.

If you show up to a recitation on time (no more than 10 minutes late), and earnestly work on the problems, you will receive full credit for that recitation. If you complete your packet before the recitation is over and explain your answers to the TAs' satisfaction, you will receive full credit and be allowed to leave early.

If you can't make your normal timeslot, fill out the absence form on our website **before your recitation time**. We'll have a virtual "makeup" recitation Sunday evenings each week and you can attend the makeup session instead or another recitation that week.

If you need an extension beyond this **you must** email Ellis either a doctor's note or a dean's note which confirms extenuating circumstances. Travel does not qualify as extenuating circumstances. In this case, you will receive an extension until the following Sunday and you may do the recitation on your own and get it checked off at TA office hours (not Ellis' office hours and not at recitation).

Generative AI and any other online resources—apart from official course materials from this course—are not allowed at recitation. Again, since you are graded on showing up and working on the problems, the use of such tools and materials will not improve your grade.

Proof Reviews

Five times throughout the semester—once for each of the five course topics—we will ask you to schedule a 15-minute meeting with a TA for a proof review. In this meeting, you will be asked to present to the TA a solution to one question from one of the designated homeworks for that topic (listed on the course calendar), and asked some follow-up questions about your proof, the assignment, and/or concepts recently covered in class. We do not expect a memorized, pitch-perfect performance; rather, we want to see that you are following the course and doing the homework yourself, and that you can explain your work coherently.

The TA running your review will grade it on a scale from 0 to 2. The grading scheme is effectively pass/fail: a score of 1 or 2 is worth full credit. We expect and will be very satisfied if all reviews this semester score a 1! Scores of 2 are reserved for exceptionally clear, detailed, precise responses, though a 2 earns the same full credit as a 1. Any student scoring a 0 will not receive points for that review.

We will describe the scheduling mechanism for reviews early in the semester; they will not begin until after Homework 2 has been returned. Each topic's review takes place during a roughly week-long window listed on the course calendar; each window opens only after you have received feedback on that topic's homework. Note that, in some cases, the proof reviews for a topic may appear after the first exam covering that topic.

If you are not able to complete a proof review during its window, **you must** email Ellis either a doctor's note or a dean's note which confirms extenuating circumstances. Travel does not qualify as extenuating circumstances. In this case, you will receive an extension of exactly one week from the end of the proof review window and you may make up the proof review at TA office hours (not Ellis' office hours and not at recitation).

Generative AI and any other outside resources—apart from official course materials from this course—are not allowed at proof reviews.

Exams

There will be three in-class exams and one final exam. The questions on the exams will draw heavily from the homeworks and recitations. The exams will be in person and you are expected to be present in person for it. The times and locations of these exams can be found on the course webpage. If you have any conflicts with any of the exams, please inform Ellis and the HTAs as soon as possible, at least two weeks before the exam. Travel plans are *not* a valid excuse for missing an exam. Final exam excuses must be approved by the university.

These exams will be closed-book and you will not be allowed to use generative AI tools or any other online resources for them.

We want to measure your understanding of the course content on your best day and give you multiple chances to demonstrate your understanding. For this reason, your exam grade is computed as follows.

The course has 5 topics: logic, math foundations, number theory, combinatorics and probability. For each of these topics you will receive a grade and your exam grade is the average of your grade across these topics. You will be tested on each topic on an exam between 2 and 3 times and your grade for that topic is the **max** that you get on that topic across exams. More specifically, each exam will have about 25 minutes worth of problems on its respective topic. Exam 1 will cover logic and math foundations, exam 2 will cover number theory and combinatorics and exam 3 will cover probability and 1 of the previous 4 topics (logic, math foundations, number theory and combinatorics) of your choice. You will have to commit to which topic you would like to redo on exam 3 before seeing the exam. The final exam will cover every topic.

Since your grade on each topic is the max across exams, it is possible to be happy with your grades on all 5 topics before the final exam even takes place. Even so, we want to encourage you to revisit the course material at the end of the semester—returning to a topic after time away and seeing how it connects to everything that came after is one of the best ways to deepen your understanding. For this reason, **in order to pass the course you must earn at least a 50% average on the final exam**, no matter your grades going into it.

As each exam approaches, we will provide you with study guides, practice exams and the opportunity to do a mock exam in person and go over answers with TAs. The mock exams will generally be held in the time slots that would have been recitations for the week before the exam.

Overall Grade Breakdown

The following is a breakdown of how you will be graded in this course.

Type	*Percentage*
Homework	5%
Recitation	15%
Proof Reviews	10%
Exams	70%

The cutoffs for grades will follow the usual distribution: an A is 90% to 100%, a B is 80% to below 90%, a C is 70% to below 80%, below 70% is NC. 70% or higher is an S. If the average grade is low, we might curve grades up (i.e. in your favor). Students taking the course S/NC will receive a grade of "S with distinction" if they pass the course with a grade that would otherwise earn a high A.

Note that if you attend recitation and turn something in for all homeworks you are already starting with 20%.

Getting Help From Us

We're here to help! You can get help from us at office hours, on EdStem or by email.

Hours

Office hours will be held throughout the week in person (see the calendar on our course website for times and locations). If any changes are made to the hours schedule, these changes will be reflected in the calendar.

Before going to office hours, you should read over the whole problem set. Have at least a general idea of the first steps you might take, even if you aren't sure what will pan out.

At office hours, we encourage students to collaborate—being able to collaborate is an essential skill in mathematics—and seek help from a TA only when necessary to make progress. We want hours to be a place for students to practice and hone their problem-solving skills with each other. **While attending TA hours is not required in this course, it is often the key ingredient to succeeding.**

What to Expect at Hours

Here's what you **should** expect to see/do at hours:

- Work in small groups with other students to solve the homework problems.
- Get advice from a TA when your group gets stuck.
- Have general concepts from class reinforced by a TA.

Here's what you **shouldn't** expect to see at hours:

- Students who have already solved problems giving the solutions to other students.
- TAs leading lecture-style presentations that work through entire problems.
- Students working on typing up their finalized submissions.

We reserve the right to add/remove policies as necessary to keep office hours as effective as possible.

EdStem

When you have questions about an assignment or the course material in general, we encourage you to use EdStem! It's an online forum that allows you to ask questions either publicly to the class (including the TAs) or privately to just the TAs.

Here are our EdStem guidelines:

1. Any post containing part of your solution to a problem should be private, while high-level conceptual questions can be public; we reserve the right to change a post to private if it reveals too much information!
2. Answering posts will operate similarly to hours; as such, do not ask questions like "is my solution correct".
3. Check pinned FAQs or search for closely related posts (some students may have asked the same questions before).
4. Categorize your post under the correct assignment to decrease the chances of it being lost.
5. Be respectful to fellow students and TAs!

Contacting Us by Email

If you have any questions or comments that you cannot get answered at hours or on EdStem, you can reach us by email. You can email the TA list at cs0220tas@lists.brown.edu, the HTAs and Ellis at cs0220headtas@lists.brown.edu or Ellis directly at ellis_hershkowitz@brown.edu.

Community Guidelines

A significant part of this course will have you collaborating with other students on homework assignments and in recitation. As you do so, please keep the following in mind:

1. We are not all coming to this class with the same background.
2. Give other people room to contribute, and listen to what they have to say.
3. Don't hesitate to work with new people.

Academic Integrity

Please note that cheating on exams will entail significant penalties. The following is an excerpt from Brown's Academic Code.

> Academic achievement is ordinarily evaluated on the basis of work that a student produces independently. Infringement of the Academic Code entails penalties ranging from reprimand to suspension, dismissal, or expulsion from the University.
>
> A student's name on any exercise is regarded as assurance that the exercise is the result of the student's own thoughts and study. Where collaboration is authorized, students should be very clear as to which parts of any assignment must be performed independently. In writing examinations and quizzes, the student is required to respond entirely on the basis of their own memory and capacity, without any assistance whatsoever except what is specifically authorized by the instructor. Cheating on examinations and quizzes can take at least the following forms: using another individual to take an examination in one's place, bringing into the exam room unauthorized materials from which one gains unfair assistance; improper collaboration or unauthorized assistance on take-home examinations.

Accommodations

Please inform Ellis early on in the term if you have a disability or other condition that might require accommodations or modification of any of the course procedures. If you would like to discuss the process for requesting accommodations, you can contact Student and Employee Accessibility Services at 401-863-9588 or seas@brown.edu.

If your religious observance will conflict with course exams or assignments, please inform the instructors as early as possible according to university policy.

Further Resources

Our hope is that this is a welcoming and inclusive course. If you feel you have been mistreated please feel free to contact Ellis directly or consider reaching out to some of the student advocates in the department. If you feel you might be the victim of harassment, consider reaching out to the Brown Title IX Office.

If you feel you are overstretched or otherwise psychologically distressed we encourage you to reach out to Brown Counseling and Psychological Services (CAPS). You may also find these resources from Brown Health and Wellness (and links therein) useful.