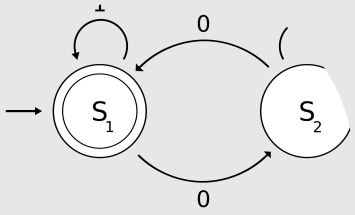

Mathematical Foundations of Computer Science

CS 234

Instructor Info

Prof. David M. Kahn

Office Hours: Mon 11am-12:30pm, Wed 1:30pm-2:30pm, Thurs 9:30am-11am

Olin 212

courses.denison.edu/courses/13965

kahnd@denison.edu

Course Info

Prereq: MATH 130, 135, or 145; and CS 109, 110, 111, or 112

Mon, Wed, & Fri

3pm-3:50pm

Talbot 210

TA Info

Khoi Van

Office Hours: T & Th, 3-5pm

Olin 220

van_k1@denison.edu

Course Description

The goal of this course is to provide an understanding of the mathematical techniques that underlie the discipline of computer science. In this course, students learn mathematical proof techniques, such as induction and proof by contradiction, and how to write rigorous proofs. It also serves as an introduction to the fundamentals of the theory of computation. Models of computation, namely finite automata and Turing machines, are studied with the goal of understanding what tasks computers are and are not capable of performing.

Learning Goals

After taking this class, a student will be able to

- formally express computational properties in mathematical language
- reason about automaton models of computation
- competently write proofs using techniques like induction
- verify properties of code that uses loops and/or recursion
- understand the limits of computation

Academic Credit

This course fulfills a (non-lab) science divisional requirement and a quantitative competency for Denison's general education requirements. This course also adheres to Denison's Academic Credit Policy, including a weekly expectation of 8 hours of work outside class on average. This time will be spent working out problems, writing proofs, reading the textbook, and going over notes/feedback.

Textbook

Mathematical Foundations of Computer Science by Ashwin Lall

Grading Scheme

Grades use the following scale: grade percents in the 90s are As, 80s are Bs, 70s are Cs, and 60s are Ds. Minuses are given for grades in the bottom 3 percentage points of a given 10 point range, and pluses are given for grades in the top 4 percentage points. However, I still reserve the right to curve grades and adjust cutoffs in extenuating circumstances.

Grades are derived from the following categories with their corresponding weights:

5%	Attendance
5%	Prep Work
45%	Assignments
30%	Midterm Exams (10% each)
15%	Final Exam

Attendance

Your attendance grade is proportional to the number of in-class surveys you participate in. On 20 random days, once or twice a week, I will ask you to fill out an electronic survey in class on some question relevant to the course. Your answer to each survey will be private between yourself and course staff unless indicated otherwise. This survey will not be graded on correctness, only completion.

FAQs

Why is this course important to a software engineer?

Software engineers, like other engineers, must build things that are reliable. The engineers who design a bridge need to do math (physics calculations) to ensure that their bridge won't collapse. Software engineers must do the same for their code. Software errors have caused global system failures, cost financial firms hundreds of millions of dollars, crashed planes with automated flight systems, caused medical equipment to deliver lethal doses of radiation, and much more. This course provides background with some of the basic tools you will need to prove your code is correct so that you don't cause these same problems. Entire branches of big companies like Meta and Amazon are devoted *just* to ensuring code is correct. I should know—I've worked in those branches of both companies.

What do you use for writing math?

I personally use LaTeX edited in VSCode. An online LaTeX interface called Overleaf is also available.

Will I really use the course content?

Every while-loop and if-then-else statement uses logic. Virtually every data structure you ever work with will require induction to reason about. Virtually every piece of code you run is parsed with a finite automaton and executed using some recursive (inductive) evaluation scheme on something equivalent to a Turing machine. And all this just scratches the surface.

Prep Work

Prep work consists of a short assignment where you gather definitions and consider simple examples. These assignments are graded on effort. The purpose of these assignments are to prepare for the week's content so that class can better be spent going into examples and correcting misconceptions.

Assignments

Assignments should be submitted electronically as a PDF, preferably typeset in LaTeX, but pictures of legible writing will also be accepted (as a PDF). Assignments may also include a coding component which is to be submitted as a Python file. The lowest two assignment grades in good academic integrity standing will be dropped.

Midterm Exams

Midterm exams will be given in class. Make sure to bring a writing implement.

A "cheat sheet" will be allowed during each exam, which must be handwritten by yourself (digitized handwriting is OK) and fit onto a single side of a standard 8.5x11 inch or A4 piece of paper. The other side of the paper must be blank. The cheat sheet must have your name clearly legible (the name may be typed if you so wish), and it will be collected with the exam.

Calculators are also allowed during exams.

Final Exam

The final exam will be run similarly to the midterm exams, including the allowance of a cheat sheet and calculator. The final exam is on Saturday, May 10th from 2pm-4pm.

External Collaboration

Unless noted otherwise, you may consult with external resources and people on assignments. However, if you do, you *must* adhere to the following guidelines. Failure to do so can result in an academic integrity violation.

- *Attribution Policy* – For all collaborations, you must submit some short citation text with your assignment that lists the following 3 points: who/what you worked with, what parts of the assignment each person/resource helped with, and a sentence or so for each person/resource describing the nature of your collaboration. For example, "Éva Tardos showed me how to use a loop on question 3," "I asked ChatGPT what the parts of an inductive proof were for this question," or "I looked up a tutorial for a similar problem at this link:..."
- *Whiteboard Policy* – When working out solutions collaboratively, you must approach the collaboration as follows: work out answers together on a whiteboard (or similar), but do not yet formally write up your submissions. Then fully erase that whiteboard. Finally, everyone goes off to write their solutions alone, with no recorded notes of the whiteboard contents. This policy allows ideas to be shared between students, but their written solutions should not match.

Such resources and people that you might consult include students outside your assignment group, friends outside of Denison, academic papers, tutorials, and similar. However, this policy does not allow you to view solution manuals, ask help forums/generative AI for solutions, or engage in similar conduct that would cause the work you submit to not be your own. Such behaviour constitutes an academic integrity violation.

Citation is key to maintaining academic integrity. Nonetheless, note that copied solutions are not eligible for credit even with proper citation.

For the purposes of this class, you do not need to cite the professor, textbook, TA, tutors, or similar course resources. You also do not need to cite sources used for help with non-course-content, such as instructions for how to create a `.pdf` file.

Late/Make-Up Policy

Attendance may be excused, reducing the total number of days considered (e.g., from 20 to 19). If you are absent on the day of a poll for an excusable reason (e.g. sickness, athletic travel, family emergency, etc.), please contact me.

Prep work will not be accepted late except due to unplanned absences like being sick. If out for multiple days, prep work may also be excused.

Late assignments will only accepted up to two days late, but will be penalized. Within the first 2 hours of the due time, 1% of earned points will be deducted every 6 minutes. Otherwise, within the first day, 20% of earned points will be deducted. During the second day, 50% of earned points will be deducted.

Extra time will not be given for arriving late to an exam. If you know you will be absent the day of an exam, then you must let me know in advance to work out alternative accomodations.

I reserve the right to relax this policy for extenuating circumstances. Do not hesitate to let me know if additional accomodation might be needed.

Contact Policy

Office hours are your times to talk to me in person about whatever. Come by to get help with assignments, ask course-related questions, or just hang around.

If something comes up while taking this course, big or small, do not be afraid to contact to me about it. Life happens, and existing in the "real world" always involves balancing and negotiating different deadlines and responsibilities. I will do my best to respond to emails within one or two business days.

TA Policy

We are fortunate to have exceptional CS undergraduate students serve as course TAs. They provide students with the ability to seek additional help with their course, often at times of the day when professors are less available. Please keep in mind the following guidelines to have the best interaction with your course TAs.

- Remember that your TA is an undergraduate student too, with their own courses and their own work. All of us are human and have busy lives.
- Your TA has posted hours and a room where they are available. This is the time the TAs are paid for their work. Please do not ask a TA to meet or help you outside of posted hours. Please do not expect them to exceed their posted hours, even if you need additional help. The course professor has usually instructed the TA to refer students back to the course professor if inquiries for help are made outside of posted hours. The TA is not a 24/7 on-demand resource.
- You must do the heavy lifting. The TA will not solve the project or problem for you. The course instructor has typically asked the TA to give students gentle assistance in solving a couple of small issues. If you are in a position where you need more help to complete the project, you should seek help from the course instructor. Please understand that the TA may say you need more help than the TA is available to give and refer you to the instructor.
- Your TA is hired to help with a specific course. They are not general-purpose department assistants. Please only approach the TA who has been assigned to your specific course. In some cases, you may be able to seek assistance from a TA in a different section of the same course.
- Your TA does not evaluate or grade student work. Please do not ask them questions like "Is this project complete?" or "Can you show me the errors in this project?". It is your job to debug your work, to test your work. The TA is there to help you with smaller challenges that you have already identified. The TA cannot explain scores on exams or projects—ask the course professor about all grading and evaluation questions.
- Desperation is never a good situation. Plan ahead. Avoid procrastination. You will have more positive interactions with your TA (and learn more) if you work with your TA well before the assignment deadline. You will usually have more time with your TA if you work ahead of the deadlines. TA hours can be busy the day before a deadline.
- Seek kind and professional interactions with your TA. Do not put pressure on them to exceed their duties. Please treat them with respect and kindness. Respect their boundaries.

AI Policy

AI tools like ChatGPT and GitHub Copilot have risen heavily in popularity. Many modern programmers do use such AIs in their workflow. Unless otherwise noted, I will not ban you from using such tools. However, I do require that they are treated like any other source: you may *not* ask them to generate solutions, and you may *not* copy their outputs. Such tools may only be used to, e.g., provide high-level reference or a partner to bounce ideas off of. Additionally, the use of such tools must be cited as per the external collaboration policy. Failure to do so can result in an academic integrity violation.

Beware: these tools are very good at sounding correct even when they are wrong. There are random large gaps in their quantitative and technical reasoning, and they are not very good at getting to the point in their writing. In the end, you are fully responsible for anything you submit, so consider such tools carefully.

Academic Integrity

Proposed and developed by Denison students, passed unanimously by DCGA and Denison's faculty, the Code of Academic Integrity requires that instructors notify the Associate Provost of cases of academic dishonesty. Cases are typically heard by the Academic Integrity Board which determines whether a violation has occurred, and, if so, its severity and the sanctions. In some circumstances the case may be handled through an Administrative Resolution Procedure. Further, the code makes students responsible for promoting a culture of integrity on campus and acting in instances in which integrity is violated. Academic honesty, the cornerstone of teaching and learning, lays the foundation for lifelong integrity.

Academic dishonesty is intellectual theft. It includes, but is not limited to, providing or receiving assistance in a manner not authorized by the instructor in the creation of work to be submitted for evaluation. This standard applies to all work ranging from daily homework assignments to major exams. Students must clearly cite any sources consulted—not only for quoted phrases but also for ideas and information that are not common knowledge. Neither ignorance nor carelessness is an acceptable defense in cases of plagiarism. It is the student's responsibility to follow the appropriate format for citations. Students should ask their instructors for assistance in determining what sorts of materials and assistance are appropriate for assignments and for guidance in citing such materials clearly.

Note on Technology: Unauthorized use of technology (including, but not limited to, artificial intelligence sites and translation programs) in the preparation or submission of academic work can be considered a form of cheating and/or plagiarism. Instructors may at their discretion create assignments that incorporate the use of supporting technologies and will inform students of acceptable uses of technology in their courses. It is the responsibility of the student to ask the instructor for clarification whenever they are unclear about the parameters of a specific assignment and to understand that presenting the work of artificial intelligence as your own constitutes a violation of Denison's Code. Cases of suspected inappropriate use of technology may be submitted to the Academic Integrity Board to initiate an investigation of academic dishonesty. For further information about the Code of Academic Integrity, see `http://denison.edu/academics/curriculum/integrity`.

Penalty

I would rather you turn in a partially complete assessment than intentionally commit an academic integrity violation—or even turn in nothing at all. For this reason, if a violation is found to have occurred, I reserve the right to assign a grade lower than 0%, usually *negative fifty percent* (-50%). This grade may be applied to the entire assessment, regardless of how little was confirmed to be in violation of academic integrity, and this grade cannot be dropped by any drop policies for this course.

Rather than violate academic integrity, I heavily encourage you to work with TAs, use Denison's academic resources, or contact me for help.

Attendance Policy

Denison's Attendance Policy states: A hallmark of a Denison education is the small, interactive, and participatory classroom situated within a residential community. Therefore, it is essential that students be present on campus and attend the classes in which they are enrolled. Attendance policies are designed to promote the success and well-being of the individual students as well as the community of learners in each class and co-curricular undertaking. For oneself and one's peers, attendance and presence on campus are vital to the Denison education. Students are expected to be aware of the attendance policy expectations for this course. Attentive presence in class is essential to facilitate a productive learning environment.

Students with Disabilities

Students with a documented disability should complete a Semester Request for Accommodations through their My Accommodations app on MyDenison . It is the student's responsibility to contact me privately as soon as possible to discuss specific needs related to your learning in the classroom and studying. I rely on the Academic Resource Center (ARC) located in 020 Higley Hall, to verify the need for reasonable accommodation based on the documentation on file in that office. Reasonable accommodation cannot be applied retroactively and therefore ideally should be enacted early in the semester as they are not automatically carried forward from a previous term and must be requested every semester.

Logistic arrangements for testing-related accommodations should be made at least a week in advance of an evaluation and follow the Exam Accommodation Policy.

Appropriate Use of Course Materials

As an institution which strives to inspire and educate our students to become discerning moral agents and active citizens of a democratic society, we are committed to complying with all laws regarding copyright throughout the University. This syllabus and all course materials used in this course may be copyrighted and accordingly will be governed by the provisions of the U.S. copyright law (for an overview see `https://copyright.gov/circs/circ01.pdf` and for fair use guidelines see `https://copyright.gov/fair-use/`). In particular, posting any course materials on commercial sites or creating a bank of materials for distribution to other students may be considered a violation of the University's Code of Academic Integrity as well as a breach of copyright law. If you have any questions about these guidelines, please speak with your instructor.

Writing Center

Every writer—no matter the course or their experience level—needs a reader and benefits from deep conversation about their work! At the Writing Center, student consultants are eager to support you at any stage of the writing process including (but not limited to): deciphering assignment instructions, brainstorming, developing an argument, organizing your ideas, integrating research and sources, working with faculty feedback, and/or polishing a draft. Consultants, who are themselves experienced writers from a range of areas of study, are specially trained to support writing for any course or purpose from lab reports, research papers, and informal writing assignments to cover letters, personal statements, and other application materials. The Center welcomes writers from all backgrounds and levels of college preparation. Appointments can be scheduled for 25 or 50 minutes at `https://denison.mywconline.com/` and take place in-person in the Atrium level of the Library (A22).

Multilingual Support

Students who use English in addition to other languages are welcome to use the resources available at the Multilingual Learning Office (MLO). The MLO includes Morayo Akinkugbe, PhD, the Assistant Director of Multilingual Programming and Support; Anna Adams, the English Language Support Specialist; and the student consultants who work with them. They are all trained and experienced in helping students address the different issues that arise when working in more than one language. If English is not your first or only language, please consider utilizing this resource, which is available to ALL Denison students. Dr. Akinkugbe, Ms. Adams, and the student consultants offer a variety of support for L2 students, including consulting with you about your written language (grammar, syntax, word-choices), developing strategies to manage your reading assignments, assisting with class conversation and presentations, and helping to devise ways to develop and effectively use all your skills in English. You can set up an appointment via `https://denisonuappointments.as.me/mlo`, or by emailing the Multilingual Learning Office directly at englishhelp@denison.edu.

Reporting Sexual Misconduct

Essays, journals, and other coursework submitted for this class are generally considered confidential pursuant to the University's student record policies. However, students should be aware that University employees are required by University policy to report allegations of discrimination based on sex, gender, gender identity, gender expression, sexual orientation, or pregnancy to the Title IX Coordinator. This includes reporting all incidents of sexual misconduct, sexual assault, and suspected abuse/neglect of a minor. Further, employees are to report these incidents that occur on campus and/or that involve students at Denison University whenever the employee becomes aware of a possible incident in the course of their employment, including via coursework or advising conversations. There are others on campus to whom you may speak in confidence, including clergy and medical staff and counselors at the Wellness Center. More information on Title IX and the University's Policy prohibiting sex discrimination, including sexual harassment, sexual misconduct, stalking and retaliation, including support resources, how to report, and prevention and education efforts, can be found at: `https://denison.edu/campus/title-ix`.

Departmental Values

1. Embrace intellectual independence—Embrace the departmental mission and the core learning goals of each course as primary objectives. Focus actions and intentions to learn the material and cultivate a problem-solving mindset, not just to get assignments completed.
2. Be respectful—Strive for respectful, meaningful, and productive relationships between and across roles, genders, nationalities, backgrounds, and identities. Proactively contribute towards a learning environment that nurtures and respects all people.
3. Act with integrity—Act with integrity and honesty when representing one's self and one's capabilities. Take pride in discovering the best version of one's self.
4. Practice responsible workplace behaviors—Adopt and practice professional behavior. Strive to develop productive work habits.
5. Grow through failure—Be courageous with experimentation and seek out opportunities outside one's comfort zone. Recognize that failure is an important part of the learning process. We grow as we encounter and strive to overcome obstacles.

Attribution for This Document

Various statements in this syllabus were sourced from those disseminated by various Denison offices and from departmental course materials.

Dates

1/22	-		(spring break)
1/24	Assignment 0 due 11:59pm		
1/27	Prep 1 due before class	3/24	Prep 8 due before class
1/29	-	3/26	-
1/31	Assignment 1 due 11:59pm	3/28	Midterm 2 in class
2/3	Prep 2 due before class	3/31	Prep 9 due before class (last day to drop)
2/5	-	4/2	-
2/7	Assignment 2 due 11:59pm	4/4	Assignment 7 due 11:59pm
2/10	Prep 3 due before class	4/7	Prep 10 due before class
2/12	-	4/9	-
2/14	Assignment 3 due 11:59pm	4/11	Assignment 8 due 11:59pm
2/17	Prep 4 due before class	4/14	Prep 11 due before class
2/19	-	4/16	-
2/21	Midterm 1 in class	4/18	Assignment 9 due 11:59pm
2/24	Prep 5 due before class	4/21	Prep 12 due before class
2/26	-	4/23	-
2/28	Assignment 4 due 11:59pm	4/25	Midterm 3 in class
3/3	Prep 6 due before class	4/28	Prep 13 due before class
3/5	-	4/30	-
3/7	Assignment 5 due 11:59pm	5/2	Assignment 10 due 11:59pm
3/10	Prep 7 due before class	5/5	(last day of class)
3/12	-		
3/14	Assignment 6 due 11:59pm	5/10	Final Exam 2-4pm