College of Engineering and Mathematical Sciences
Computer Science

CS 2250 B / Computability and Complexity / 2025 Fall

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Office hours:
M 02:30–04:00 PM, Th 09:00–10:30 AM,
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Location: Common area Innovation / Discovery, level 2

Class meetings
Section B: T/Th 02:50–04:05 PM, Cohen 101

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Welcome to the course!

Overview: This course is a study in automata, automata as models of computation, the fundamental limits of computing, and complexity theory. Topics include: formal languages, regular expressions, deterministic and non-deterministic finite automata, context-free grammars and pushdown automata, Turing machines, decidability, computable functions, reducibility, and time complexity classes (P, NP, NP-complete, NP-hard). This course fulfills the Qualitative Reasoning (QR) requirement of the Fall 2020 revision of the Catamount Core curriculum. See: https://go.uvm.edu/qr.

Course materials: Textbook: Sipser, Michael. *Introduction to the Theory of Computation*, 3rd edition. ISBN: 978-1-133-18779-0. eBook rental available direct from Cengage. ISBN: 978-1-285-32073-1. If you are already using a Cengage text in another course, you may already have access through Cengage Unlimited. Other materials will be supplied on Brightspace.

Software: We'll do a little programming, so please be prepared with a reasonably current version of Python (>= 3.10) and working IDE of your choice. **If you don't meet these requirements, please address them promptly.** If you need help, come to office hours or help desk. Don't delay.

Learning objectives:

- Prove properties of languages and automata using formal mathematical methods.
- Collaborate with peers to solve problems and present results.
- Recognize flaws in invalid proofs.
- Trace an automaton's action on a given input (*e.g.*, determine whether a given DFA accepts a given string).
- Design automata (*e.g.*, DFA, Turing machine, *etc.*) or context-free grammar to recognize a specific language or to satisfy a given property.
- Describe the language recognized by an automaton or generated by a regular expression or context-free grammar.
- Understand decidability and undecidability.
- Understand how reduction techniques are used to prove decidability or undecidability.
- Understand relationships between languages in the context of the Chomsky hierarchy.
- Explain the relationship between time complexity classes P, NP, NP-hard, and NP-complete.

Important websites:

- Brightspace, for course materials, announcements, and submitting certain assignments.
- Gradescope, for submitting certain assignments.

Correspondence: Please use email for electronic correspondence (and not MS Teams). As I teach multiple courses please indicate the course in which you are enrolled in the subject line. Please use your UVM email for all correspondence.

Online quizzes: There will be eleven online quizzes administered on Brightspace. These will occur in weeks in which there is no exam. Online quizzes will be open book, open notes, but no collaboration. There will be no make-ups for missed quizzes. However, the lowest score will be dropped, in part to accommodate illness or other unforeseen events.

In class exams: There will be two partial exams administered in class (see schedule). Each in-class exam counts for 10% of your overall grade. These will be administered in pencil and paper format. For in-class exams you will be allowed two 8.5" × 11" pages of *handwritten notes* (both sides OK).

Active learning exercises: Throughout the semester, we'll have active learning exercises in class. These will be conducted in small groups (*i.e.*, three to five students per group). Active learning exercises will be graded on a simple check / check plus kind of scale. Weights of individual exercises TBD.

Homework: You will have five homework assignments at various intervals. Information about homework, including due dates, will be announced in class and posted on Brightspace. Each assignment counts for 5% of your overall grade. All homework is due by 11:59 PM on the specified due date and should be submitted via Gradescope (links on Brightspace).

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Final exam: The final exam, which counts for 20% of your overall grade, will be administered at times scheduled by the Office of the Registrar. Exams will be administered using pencil and paper. You will be allowed two 8.5" × 11" pages of *handwritten notes* (both sides OK). The final exam will be cumulative, but primary emphasis will be on Turing machines, decidability, reducibility, and time complexity classes.

Weekly schedule of topics (tentative and subject to change):

Week	Topics covered	Assessment
01	Math foundations; introduction to computability; Chomsky hierarchy	quiz
02	Deterministic finite automata (DFAs)	quiz
03	Non-deterministic finite automata (NFAs); subset construction	quiz
04	Regular expressions; state elimination	quiz
05	Non-regular languages; pumping lemma for regular languages	quiz
06	Review: regular languages and finite automata	exam
07	Context-free grammars (CFGs); Backus-Naur form (BNF)	quiz
08	Pushdown automata; Chomsky normal form (CNF)	quiz
09	Review: regular and context-free languages	exam
10	Turing machines; Church-Turing thesis	quiz
11	Decidability and the *Entscheidungsproblem*	quiz
12	Reducibility; mapping reducibility and computable functions	quiz
13	Computational complexity; the classes P and NP	quiz
14	NP-Completeness and Cook-Levin	quiz
–	Reading and exams	exam

Grading:

Component	Weight
Online quizzes (11, drop 1)	10%
In class exams (2 @ 10% each)	20%
Active learning and participation	15%
Homework (5)	30%
Scribing	5%
Final exam	20%
TOTAL	100%

Assignment of letter grades will be on a conventional scale. Any grade appeal (assignment, quiz, lab, exam, *etc.*) must be directed to your grader within one week of the grade being posted. If grading is done on Gradescope (*e.g.*, for homework), there's a *regrade request* feature which should be used for grade appeals.

Academic integrity: The Department of Computer Science enforces UVM's Code of Academic Integrity. Any suspected violation of this policy will be referred immediately to UVM's Center for Student Conduct (https://www.uvm.edu/sconduct). Sanctions for a violation may include a grade of XF in the course. Additional violations can result in dismissal from the university. In a word: *Don't*. All students should read and understand this policy. See: https://go.uvm.edu/cai.

Collaboration on quizzes and exams is strictly prohibited. Use of online services as a source of solutions is strictly prohibited. Using generative AI such as ChatGPT or Claude, or websites such as Chegg or Course Hero to complete coursework is a form of academic dishonesty. Work you submit for an individual grade must be your own. Any work not produced by you must be cited. For certain assignments, students may collaborate on homework (typically limited to teams of two or three). If you collaborate with another student on an assignment, be sure to indicate team members as specified. If you have any questions, ask!

Any attempt to tamper with or defeat any autograder is a form of academic dishonesty. This applies wherever autograders are in use, for example on Brightspace or Gradescope.

All code submitted by students is subject to code similarity review.

Exams, quizzes, homework assignments, answer keys and solutions, presentations or lecture notes, specifications and rubrics are copyright protected works, unless clearly and explicitly indicated otherwise. Any unauthorized copying or distribution of protected works is a violation of federal law and may result in disciplinary action. This includes submission of protected works as prompts to generative AI. Sharing of course materials without the specific, express approval of the instructor may be a violation of the University's Code of Academic Integrity and an act of academic dishonesty, which could result in disciplinary action. Violations will be handled under UVM's Intellectual Property Policy and Code of Academic Integrity, as appropriate. See: https://go.uvm.edu/ipp and https://go.uvm.edu/cai.

Policy regarding AI: Use of generative AI (ChatGPT, Claude, CoPilot, Llama, DeepSeek, Gemini, *etc.*) is strictly prohibited as a means of researching, producing, or verifying answers in exams and quizzes. No exceptions.

Most IDEs have some kind of AI assistant built-in or available as a plug-in (*e.g.*, GitHub CoPilot in VS Code, JetBrains AI Assistant, *etc.*) and there are many other tools for assisted coding (Replit, Cursor, *etc.*). These have their uses, but for your own learning, it's often best to disable them when writing code to avoid cognitive off-loading. Please avoid the use of Replit, Cursor, and other such tools. It's OK if you use built-in IDE assistants but use them wisely, and you must indicate whether or not you've used them by including a comment in your code. *You should be able to read, understand, and explain in detail the workings of any code you may submit for this course. Do not submit anything you don't completely understand.* I reserve the right to ask you questions about code you submit and you should be prepared to answer on the spot.

Use of generative AI for producing prose—reflections, essays, or similar writing—is prohibited. Feel free to use spell checkers and grammar checkers. UVM has a site license for CoPilot, which is integrated into UVM-supplied instances of Microsoft Word. This is very much preferred to outside, third-party tools. If you do use something other than UVM's CoPilot instance you must make a note of it in a comment, footnote, or end note.

If you have a documented disability (*e.g.*, dysgraphia) or English is not your native tongue, please contact me about an accommodation if you think certain AI tools would be of legitimate benefit in your writing.

Any unauthorized use of generative AI, or uncited use where permitted, constitutes a violation of UVM's Code of Academic Integrity and Code of Student Conduct. Violations or suspected violations will be referred to the Office of Student Conduct.

There are many ethical issues surrounding the use of generative AI. If you are uncomfortable about using generative AI, you are in no way obliged to use it.

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If you have questions about generative AI or this policy, please do not hesitate to ask.

Attendance: The UVM attendance policy is available at https://go.uvm.edu/srr. There will be no make-ups for in-class active learning exercises if you did not attend class without prior notification and approval. While your attendance is ungraded, we will have frequent in-class assessments, and a good attendance record may be taken into consideration when handling exceptions if they arise.

If you are not able to attend in-person classes please notify the instructor via email as soon as possible. Depending on the nature of your absence, it may be appropriate for you to contact UVM Student Health Services (https://www.uvm.edu/health/SHS), CEMS Student Services (https://www.uvm.edu/cems/student-services), or the Dean's Office for your college. In many cases, these can provide an official request for flexibility on your behalf. While reasonable accommodations will be granted in the event of documented illness or emergencies, you are responsible for making up any work you have missed.

The secret word is "rampant."

Class participation: You are expected to be an active participant in class. The more engaged you are, the more you will learn—and the more fun you'll have. This includes being prepared and attentive, responding when called on, participating in group discussion, and asking questions as appropriate. When it comes to asking questions, *please don't be shy!* There's no such thing as a "dumb" or "silly" question. If there's something you don't understand—*ask*! Asking questions helps you understand the material presented in the course. Asking questions is good for your classmates. It's almost certain that if you need clarification on some point, that there's at least one other student in the class with the same question. So help each other out—*ask*! Finally, when you ask a question you help the instructor to do a better job of explaining. If someone explains something, and you still don't quite grasp it, it's not unlikely that the explanation could be improved or clarified.

Late policy / extensions: Each homework assignment has a specific due date / time. You may submit work up to 24 hours after the due date / time, however, late submissions will be penalized 20%. Submissions that are more than 24 hours late will not be accepted unless an extension has been granted. We will consider reasonable requests for extensions when extenuating circumstances arise. (It can't hurt to ask.) However, extensions will not be granted if the request for extension is made within 24 hours of the time an assignment is due, except in the most extraordinary circumstances. So if you wish to request an extension, *do so early*! If an extension is granted, you must submit your work by the agreed-upon extension date.

Student course evaluations: Students are warmly encouraged to complete an evaluation of the course at its conclusion. Evaluations are anonymous and confidential, and the information gained, including constructive criticisms, will be used to improve the course.

Diversity, equity, and inclusion: UVM is a place where you should be treated with respect and kindness. We welcome individuals of all ages, backgrounds, beliefs, interests, ethnicities, genders, gender identities, gender expressions, national origins, religious affiliations, sexual orientations, ability, and other visible and non-visible differences. All students are expected to contribute to a respectful, welcoming and inclusive environment for every other member of the community. If you ever feel that you have been unfairly treated or judged by an instructor, a mentor, another student, or another member of the community, please let someone know. Your instructors and advisors in the CEMS Office of Student Services are available to discuss any concerns, or you can report an incident of bias through the bias report program (https://go.uvm.edu/brp).

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Conduct: Be kind to one another and to yourself. Be respectful of yourself, others, and the institution. Please arrive on time. Please, no food in class. Please, no cell phones in class. You may use a laptop or tablet, but only for active learning sessions, pair programming, taking notes, or assistive technologies.

For other policies on classroom conduct, please see: https://go.uvm.edu/srr and https://go.uvm.edu/csc.

Accommodations: In keeping with UVM policy, if you have a documented disability and are interested in utilizing ADA accommodations, you should contact Student Accessibility Services (SAS), the office of Disability Services on campus for students. SAS works with students and faculty in an interactive process to explore reasonable and appropriate accommodations, which are communicated to faculty in an accommodation letter.

Contact SAS: A170 Living/Learning Center; +1 802 656 7753; access@uvm.edu; or visit https://www.uvm.edu/access.

If you are entitled to use the Exam Proctoring Center, please book reservations at least four days in advance.

Your identity at UVM: Students at UVM can specify the first name and pronoun they want used on campus. For information on how to update your preferred name and personal pronouns as well as keeping your legal name private, and UVM policy on lived name and pronouns, see: https://go.uvm.edu/lnpr.

Promoting health and safety: If you are concerned about a UVM community member or are concerned about a specific event, we encourage you to contact the Dean of Students Office (+1 802 656 3380). If you would like to remain anonymous, you can report your concerns online by visiting the Dean of Students website at https://www.uvm.edu/deanofstudents.

Wellbeing resources:

- Center for Health and Wellbeing: https://www.uvm.edu/health/services
- Counseling and Psychiatry Services (CAPS): +1 802 656 3340
- Food Insecurity Assistance: https://www.uvm.edu/health/food-insecurity-uvm

Student advocacy: https://www.uvm.edu/deanofstudents/student_advocacy

Religious holidays: Students have the right to practice the religion of their choice. In order to receive extensions or excused absences, you should submit via email your documented religious holiday schedule within the first week of the course. Reasonable extensions will be granted where assignment deadlines conflict with religious holidays.

Student athletes: In order to receive extensions or excused absences, you should submit via email appropriate documentation as soon as possible, preferably within the first week of the course. Reasonable extensions will be granted where assignment deadlines conflict with team events or team travel.

Statement on alcohol and other drugs: We want you to get the most you can out of this course. Therefore, you are expected to familiarize yourself and abide by the University's policies with regard to alcohol, cannabis, tobacco, and other drug use. See: https://go.uvm.edu/actd. Please do everything you can to optimize your learning and to participate fully in this course.

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Class format changes: The University of Vermont reserves the right to make changes in the course offerings, mode of delivery, degree requirements, charges, regulations, and procedures contained herein as educational, financial, and health, safety, and welfare considerations require, or as necessary to be compliant with governmental, accreditation, or public health directives.

Changes to this document: This document is subject to change. Any such change will be communicated via an announcement on Brightspace. The latest version of the syllabus will always be available on Brightspace.

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