

Theory of Computation (CS 6160) Spring 2021

Instructor: Mohammad Mahmoody

Credit Units: 3

Time and location: Fridays 1pm-3:45pm, **Rice Hall 340**. You can also join by Zoom (the class will be live streamed). The Zoom link will be available in course's Collab page.

Instructor: Mohammad Mahmoody (Rice 511) mohammad@cs.virginia.edu

Office hours: Wed 2pm-3pm, at my office (with masks) and at the same time at class's Zoom link.

Goals and objectives: The goal of this course is to understand what computation is and to learn how to formally argue about it. Doing this involves defining algorithms in a formal way in various ways and using the right theoretical tools to argue about their validity and complexity. The complexity refers to resources that we use in computation, such as time, space/memory, randomness, etc.

Textbooks: Two main sources, though we might use others as well:

- Introduction to the Theory of Computation, by Michael Sipser.
- Computational Complexity A Modern Approach, by Sanjeev Arora and Boaz Barak.

We will also benefit from the following two books:

- Quantum Computing Since Democritus, by Scott Aaronson.
- The Nature of Computation, by Cristopher Moore and Stephan Mertens.

Outline of topics:

- Computation using limited memory: Finite automata (and regular expressions), push-down automata (and context free grammars).
- Computability: Turing machines and Church—Turing thesis, decidability, halting problem, reducibility.
- Computational Complexity: The complexity of resources such as time, space, and randomness; hierarchy theorems, non-deterministic computation and the P versus NP question, complexity of games, interactive proofs and Zero knowledge proofs, cryptography (leveraging computational hardness).
- Quantum computation: due to increasing importance of quantum computing, we aim to have a brief introduction to quantum computing at the end of the semester (2 or 3 sessions).

Prerequisites: No prerequisites are enforced, yet being familiar with concepts of CS 3102 (theory of computation), CS 2102 (discrete math), and CS 4102 (Algorithms) will be extremely helpful. The key is to be comfortable with basic mathematical concepts and mathematical proofs.

Grading: There will be a take-home final exam (25% of grade) a take home midterm (25% of grade). You need to participate in at least 11 of the 14 classes to get (20% of the grade). All lectures will be streamed, so you can join through Zoom (and that does count as class participation). There will be also two assignments, which will be 15% of the grade each. All assignments and exams will be shared through <https://www.overleaf.com/> templates and you need to submit them through <https://www.gradescope.com/>.

Update about class attendance: You can choose to opt into the policy above, but if you do not, your extra 20% will be evenly distributed between the 2 problem sets (20% each) and the exams (30% each). If you want to opt into this policy, you need to keep track of your own attendance and let me know about it on Dec 3 by email. Your reports to me are based on the honor policy.

Honor Policy: Collaboration for exams is not allowed, but doing so is allowed and even encouraged for assignments. However, you have to write the assignments on your own. Within that context, all are subject to the UVa's honor policy.

<https://honor.virginia.edu/statement>

Course's pages: Main page where you can find the suggested readings:

<https://www.cs.virginia.edu/~mohammad/courses/toc/fall21/>

There will be a collab page also here at:

<https://collab.its.virginia.edu/portal/site/5b4808f2-aeba-48f2-93ac-c0edaf35a144/> where you can find the slides and recorded videos of the class.

Mailing list: theory-of-computation-fall-2021@collab.its.virginia.edu

Piazza for discussions: There is a Piazza page that is linked to class's collab system. All of after-class discussions will be through Piazza, where I will answer questions. All questions about the class should be posted there publicly (i.e., visible to all) unless there is a very good reason for not doing so. Note that you can always post your questions in an anonymous way. The reason for this policy is that it is always likely that your question is someone else's question as well.

Disabilities accommodation. The University of Virginia strives to provide accessibility to all students. If you require an accommodation to fully access this course, please contact the Student Disability Access Center (SDAC) at (434) 243-5180 or sdac@virginia.edu. If you are unsure if you require an accommodation, or to learn more about their services, you may contact the SDAC at the number above or by visiting their website at <https://studenthealth.virginia.edu/sdac>

Sexual assault prevention. The University of Virginia is dedicated to providing a safe and equitable learning environment for all students. To that end, it is vital that you know two values that I and the University hold as critically important: (1) Power-based personal violence will not be tolerated. (2) Everyone has a responsibility to do their part to maintain a safe community

on Grounds. If you or someone you know has been affected by power-based personal violence, I urge you to check this link that describes reporting options and resources available: <http://eocr.virginia.edu/>

Religious accommodation. It is the University's long-standing policy and practice to reasonably accommodate students so that they do not experience an adverse academic consequence when sincerely held religious beliefs or observances conflict with academic requirements. Students who wish to request academic accommodation for a religious observance should submit their request in writing directly to me (Mohammad) by email as far in advance as possible. Students and instructors who have questions or concerns about academic accommodations for religious observance or religious beliefs may contact the University's Office for Equal Opportunity and Civil Rights (EOCR) at UVAEOCR@virginia.edu or 434-924-3200. Accommodations do not relieve you of the responsibility for completion of any part of the coursework missed as the result of a religious observance.