Theory of Computation
18.404/6.5400
Fall 2026

Michael Sipser

Course Information

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Course Outline

I **Automata and Language Theory (2 weeks).** Finite automata, regular expressions, push-down automata, context-free grammars, pumping lemmas.

II **Computability Theory (3.5 weeks).** Turing machines, Church–Turing thesis, decidability, halting problem, reducibility, recursion theorem.

III **Complexity Theory (7 weeks).** Time and space measures of complexity, complexity classes P, NP, L, NL, PSPACE, BPP and IP, complete problems, P versus NP conjecture, quantifiers and games, hierarchy theorems, provably hard problems, relativized computation and oracles, probabilistic computation, interactive proof systems.

Prerequisites

To succeed in this course, you need experience and skill with basic combinatorics, probability, graph theory, and logical reasoning, as well as comfort with theorems and proofs. If you did well in 18.062, 18.200, or any other substantial, proof-oriented discrete mathematics subject, you should be fine. The course moves quickly, covering about 90% of the textbook. The problem sets generally require proving some statement, and creativity in finding proofs will be necessary.

Note that 18.400/6.1400 has a significant overlap with 18.404, depending on who is teaching it, and it often uses the same book. It generally covers less material, in less depth, and with easier problems. Taking 18.400/6.1400 before 18.404 is not recommended.

Should I register for 18.404, 18.4041, or 6.5400?

Course 18 and 18C majors may register only for 18.404, which carries undergraduate (U) credit. All other majors, including double majors with Course 18 or 18C, should register for 18.4041 or 6.5400, which carry graduate (G) credit (may be useful in MEng and PhD programs) for the non-math major. Any of these numbers count towards the math major. The subject number doesn't affect the course material or grading.

Textbook

Introduction to the Theory of Computation, third edition, Sipser, Cengage, 2013.
You may use the second edition, but it is missing some additional practice problems.
We will cover Chapters 1, 2 (except 2.4), 3, 4, 5, 6.1, 7, 8, 9.1, 9.2, 10.2 (except the part on Primality), and 10.4 through Theorem 10.33.

Recitations

Recitations are primarily for going over lecture material in more detail, giving additional examples, and answering questions. Recitation attendance is optional, and you may attend any recitation you wish. BUT, if you are having trouble, we expect you to attend recitations weekly, and active participation may improve low grades. To help the TAs keep track of active participants, we recommend attending the same recitation consistently.

Exams (80% of course grade)

Quiz (20%): Tuesday evening 7:30–9pm, October 6, 2026.
Midterm (20%): Thursday, 2:30–4pm, October 29, 2026.
Final (40%): 3 hours during finals week, TBD.

The Quiz covers lectures 1–7; the Midterm covers lectures 1–11, focusing on lectures 8–11; and the Final covers the whole course, focusing on the second half.
All exams are closed book. No access to the textbook or course notes (printed or electronic) or to the internet is allowed. You are allowed to bring and use a one-page (printed on both sides) summary sheet (also known as a crib sheet) of your choice to the Quiz and Midterm, and two pages (printed on both sides) to the Final. The page(s) must be physical and on regular 8.5×11-inch paper. Laptops and phones are not allowed. Some exam problems may be related to the problem sets.

Problem sets (20% of course grade)

Six problem sets, roughly biweekly, according to the course schedule on the homepage. Cooperating on psets is allowed and may be helpful, but you are strongly encouraged to spend some time thinking about each problem yourself first.

Solutions must be written up individually (not copied from any source).

Using course bibles or other outside materials or results to solve the problems is not permitted. See the following policy on using AI.

Submit your problem sets online via Gradescope, due by noon as specified in the course schedule. Unexcused late psets will be accepted on the following day up to 11:59pm, but will be charged a 1-point-per-problem (out of the 10-point maximum) late penalty. Individual problem parts may be submitted late and will be charged a pro-rated 10% point penalty. After that date, problem sets may be submitted by email only. They may not be graded but will be kept for reference. Solutions will be posted soon after the late submission deadline.

The emphasis on the psets is on creative thinking rather than on long tedious write-ups. The solution to a typical problem will be roughly half a page, though some may be longer or shorter. See the posted solutions as models. You may cite a lecture, recitation, or the textbook (including problems with solutions), but you may not cite the literature, some other course, or unsolved textbook problems. Express yourself clearly so that the grader can understand what you are doing. Handwritten solutions are permitted as long as we can read them easily. If your handwriting is hard to read, use latex. If your solution involves a construction, you need to explain why it works, but you do not need to give a formal correctness proof.

Every problem set will contain one optional problem. I will consider your solutions to these challenging problems when assigning A+ grades and in choosing graders and TAs in future years. Besides that, solving the optional problems will not affect your course grade.

If personal or medical problems interfere with your work, please contact Student Support Services at `https://studentlife.mit.edu/s3` for undergraduates or GradSupport at `oge.mit.edu/student-support-development/gradsupport` for graduate students.

Policy on using AI for solving problem sets and general studying

The problem sets serve several purposes in this course: they help you learn the material through thinking deeply about the concepts; they develop your problem-solving ability by exercising your mental muscles; they give you practice expressing concepts clearly and precisely; and solving them is satisfying and fun.

Using AI (ChatGPT, Claude, Gemini, or other generative AI) to provide complete problem set solutions defeats all of these purposes and is therefore prohibited. Copying an AI-provided solution is no different than searching for the solution online and copying that. The exams will, in part, test your understanding of the problem sets, so over-reliance on AI will put you at a disadvantage.

If used sensibly, AI can enhance learning. You may use it to clarify the material, answer questions about parts you don't understand, and to provide examples and exercises. If you have worked on a problem for at least 30 minutes and feel completely stuck, it is OK to ask for a single gentle hint that doesn't give the solution away. It is also ok to ask it for advice in improving your solution write-up. Think of it like asking a TA for help. Use your judgement about how much help is beneficial, and when it goes too far. Overuse will mainly cheat yourself.

Exception: do not use AI to help you with the optional problems in any way (no hints or writeup editing).

Grading policy

Your grade will be based mainly on the Quiz (20%), Midterm (20%), Final (40%), and Problem Sets (20%). Active participation in a weekly recitation section will also be taken into account and may modestly improve an otherwise low course grade. My TAs and I use this information and our judgement to determine the course grade, rather than applying a strict formula.