Instructor: Michael Sipser, 2–365, 3–4992, `sipser@math.mit.edu`, office hours: Mo 3:00–5:00.
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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 weeks).** Turing machines, Church–Turing thesis, decidability, halting problem, reducibility, recursion theorem.

– **Midterm Exam:** Thursday, October 25, 2012

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

– **Final Exam:** 3 hours, emphasizing second half of the course.

Prerequisites

Official: 18.310 or 18.062J/6.042J. **Real:** You need to be comfortable working with mathematical theorems and proofs. Most of the assignments in this course require proving some statement and creativity in finding proofs will be necessary.

Text: *Introduction to the Theory of Computation*, Sipser, Cengage, 2012.
The new 3rd edition is preferred because it has updated problem lists, but I'll accomodate students who have the 2nd edition.

Recitations

Recitations are primarily for going over lecture material in more detail, for answering questions and for reviewing homework and exams. Recitation attendance is optional, and you may attend any recitation you wish. BUT, if you are having trouble with the course, we expect you to attend recitations weekly, and doing so may keep you from failing.
No recitations during the first week.

Grading

- **Homework:** 40% of grade. Will be 6 biweekly problem sets. Cooperation policy: Permitted though not encouraged. If you do cooperate on some problems, then solutions must be written up individually (not copied). *Using course bibles or other outside or online materials is not permitted.* Homework is due in 2–255 on Thursday by 11:00am sharp. Late homework will be accepted in 2–255 the following day up to 1:00pm, but will be charged a 1 point per problem (out of the 10 point maximum) late penalty. Homework submitted after that will not be graded but will be kept for reference. If medical problems interfere with your work, please contact Student Support Services at `http://web.mit.edu/uaap/s3/`.

- **Exams:** One midterm (20% of grade) during a class session and one final (40% of grade) during finals week. Both open book.

2012 Schedule for 18.404/6.840

1.	Sep	6		Introduction, finite automata, regular expressions
2.		11	Tu	Nondeterminism, closure properties, regular expressions $\leftrightarrow$ FA
3.		13		Regular pumping lemma, context free languages
4.		18	Tu	Pushdown automata, CFG $\leftrightarrow$ PDA,
5.		20	hw 1	CF pumping lemma, Turing machines
6.		25	Tu	TM variants, Church–Turing thesis
7.		27		Decision problems for automata and grammars
8.	Oct	2	Tu	Undecidability
9.		4	hw 2	Reducibility
		9	Tu	NO CLASSES — Columbus Day
10.		11		Linearly bounded automata, PCP
11.		16	Tu	Recursion theorem and logic
12.		18	hw 3	Time complexity
13.		23	Tu	P and NP, SAT, poly-time reducibility
14.		25		**Midterm Exam**
15.		30	Tu	NP-completeness
16.	Nov	1	hw 4	Cook–Levin theorem
17.		6	Tu	Space complexity, PSPACE, Savitch's theorem
18.		8		PSPACE-completeness
19.		13	Tu	Games, Generalized geography
20.		15	hw 5	L and NL, NL=coNL
21.		20	Tu	Hierarchy theorems
		22		NO CLASSES — Thanksgiving
22.		27	Tu	Provably intractable problems, oracles
23.		29	hw 6	Probabilistic computation, BPP
24.	Dec	4	Tu	Probabilistic computation, contd.
25.		6		Interactive proof systems, IP
26.		11	Tu	IP contd.