

final exam  
 Thu 13 December  
 2:00 pm - 4:00 pm  
 Modern Languages 311

The following is a list of major topics in this course from which the exam questions will be chosen. The exam will be aimed at testing your comprehension of major concepts and techniques covered in the course. Questions will be designed to test

1. Whether you can understand, correctly use and define major concepts introduced
2. Whether you can carry out certain important algorithms involving finite automata, pushdown automata, or decision algorithms, and can use them in simple applications
3. Whether you can apply theorems and properties that characterize languages
4. Whether you are aware of the fundamental limitations to computation, understand the notion of undecidability, and can carry out simple reduction arguments that demonstrate undecidability.

The emphasis will not be upon detailed proofs of theorems, but upon supporting your assertions by argument and upon applying results you have learned. Among the reasoning techniques expected are the ability to apply "pumping" results, and the ability to carry out reduction arguments used to prove undecidability of problems. (At least one problem of each of these kinds will appear on the exam.) You will not be expected to recall details of proofs of theorems in the text, and can have the text and other course materials with you during the exam.

### Format

The exam will consist of several medium length (approx. 10-12 minute) questions, all of equal weight. You will be asked to solve 8 of the questions in the 2 hours provided. There will be an opportunity to do one additional problem for extra credit, provided time permits.

Ground rules: This is an open book, open notes examination. You can bring any course materials, homeworks, solution sets, etc. All course materials and the text can be used. The only exclusions are:

- During the exam, you may not be in communication with others, by voice, phone, hand-held, computer or smoke signal.
- You may not connect with any site on the Internet during the exam.

Reference	Applications	Concepts/Definitions	Algorithms
Intro lecture		automaton language	
Prelim lecture	digraphs	binary relations	
Chapt. 0	bit matrix	relational calculus: $R^{-1}$ , $R^k$ , $R \circ S$ $R^*$	matrix powers
	reachability	closures	
	reflx., symm. trans.		
	expressing properties using relational calc. throughout	induction language ops: $\cup$ , $\cdot$ , $*$ regular expressions	
Text p. 16	describing sets mathematical terminology	DFA	

		configuration, $\vdash$ yield in 1 step, yield* ( $\vdash^*$ ) computation (seq. of config.) recognition, language $L(M)$ of $M$	
Text 1.1	designing FA		
Text 1.1	regular operations		
Text 1.2	non-determinism specification	NFA acceptance by NFA	
Text 1.3	editors prog. language definition	subset construction $\epsilon$ -move, $\epsilon$ -closure	Rabin-Scott $\epsilon$ -move removal
Text 1.3	from specification to machine		NFA $\leftrightarrow$ reg. exp.
Notes	sequential circuits text scanning	finite transducer	
Text 1.1 Notes	constructing machines from others		closure properties
Text 1.4 Notes	proofs of non-regularity	pumping lemma closure properties	
Notes		decision problem	decision algorithms
2.1 Notes		CFG	derivation $\rightarrow$ parse tree parse tree + traversal $\rightarrow$ derivation parse tree $\leftrightarrow$ leftmost derivation
2.1 2.2 Notes	CFG design	leftmost derivation ambiguous CFG right-linear grammar PDA, $L(M)$ , $\vdash$ configuration CFG $\rightarrow$ PDA PDA $\rightarrow$ CFG	
2.2 Notes			reachability, co-reachability grammar constructions
2.3 Notes	proofs of non-CF	closure properties	
2.3	proofs of non-CF	pumping lemma	
4.1			test for $L(G) = \emptyset$ , $w \in L(G)$
3.1 Notes	TM diagrams	TMs $\vdash$ computation, halting Turing-computable, -decidable, -recognizable algorithms vs TMs: the connection diff. betw. TM recog. $L$ and TM deciding $L$	
3.2		extensions/variations of TMs ( $k$ -tape, nondet. TMs) Enumerators and recognizability Enumerators and decidability	
3.3		Church's Thesis	
4.1			Decision Algs (DFA, NFA, CFG)
		Languages and Problems--the connection	

fig. 4.10		Relationships among language classes	
4.2	Halting Problem $A_{TM}$ Diagonalization non-recognizable sets: $\bar{A}_{TM}$		
Thm 4.22	reduction	$L, \bar{L}$ recognizable $\Leftrightarrow L$ decidable	
Thm 5.1-5.4	undecidability via reduction	$A \leq_m B$	
Cor 4.23	$\bar{A}_{TM}$ not recog.	non-TM-recog. sets	
Thm 4.11	$A_{TM}$ not decidable	TM-recog. sets	
Notes	$HALT_{TM}$ not decidable	reduction	
Notes	$E_{TM}, ET_{TM}$ etc. undecidable	reduction	
Notes	$REGUIAR_{TM}, EQ_{TM}$ not decidable	reduction	
Notes	undecidable problem		reduction
Notes		enumerable = recognizable	
Notes	decidable = enumerable in order		
Notes	undecidable language properties	Rice's Theorem	
Notes		language vs machine property	
Notes	undecidable question	machine-dependent question	