University of Nevada, Las Vegas
Computer Science 456/656 Fall 2005
Final Examination December 13, 2005

The entire examination is 300 points.

Name:_____ No books, notes, scratch paper, or calculators. Use pen or pencil, any color. Use the rest of this page and the backs of the pages for scratch paper. If you need more scratch paper, it will be provided.

1. True or False. [5 points each]

   (a) _____ Every subset of a regular language is regular.

   (b) _____ Every language which is generated by an unrestricted grammar also called *general grammar* is recursively enumerable.

   (c) _____ The question of whether two context-free grammars generate the same language is decidable.

   (d) _____ The set of all hexadecimal numerals for prime numbers is in the class $\mathcal{P}$.

   (e) _____ The question of whether two regular expressions describe the same language is decidable.

   (f) _____ The intersection of any two context-free languages is context-free.

   (g) _____ If L_1 reduces to L_2 in polynomial time, and if L_2 is $\mathcal{NP}$, then L_1 must be $\mathcal{NP}$.

2. [10 points] Which of the languages listed below are known to be $\mathcal{NP}$-complete? (Write "Yes" in the black if the language is known to be $\mathcal{NP}$-complete, "No" otherwise.)

   (a) _____ L_{3CNF}, the language of all boolean expressions in conjunctive normal form, where each clause has exactly three terms.

   (b) _____ The 0-1 Traveling Salesman Problem.

   (c) _____ The Halting Problem.

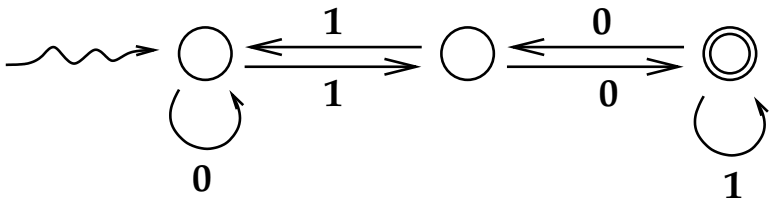
   (d) _____ The set of all encodings $\langle G \rangle$, where G is a graph that has an independent set of size 3.

3. [10 points] What class of machines accepts the class of context free languages?

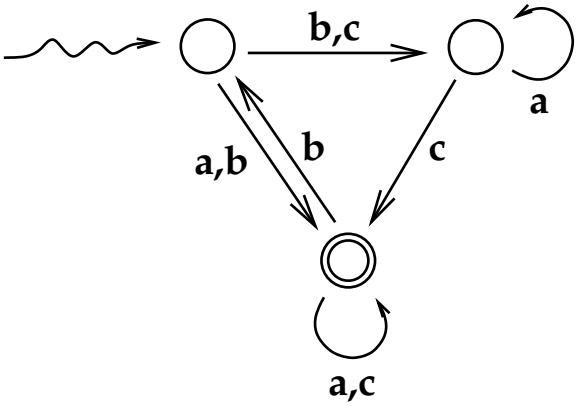
4. [10 points] What class of machines accepts the class of recursively enumerable languages?

5. [20 points] Draw the state diagram for a minimal DFA that accepts the language desribed by the regular expression `(a+b)*ab`

6. [20 points] Write a regular expression for the language accepted by the DFA shown in the figure below.



7. [20 points] Construct a minimal DFA equivalent to the NFA shown in the figure below.



8. [20 points] State the pumping lemma for regular languages accurately. If you have all the right words in the wrong order, that means you truly do not understand the lemma, and you might get no partial credit at all.

9. [15 points] Consider the context-free grammar with start symbol S and productions given below. Write a leftmost derivation of the string $bswisbwsnn$

   $S \to s$

   $S \to bLn$

   $S \to wS$

   $S \to iS$

   $L \to \epsilon$

   $L \to SL$

10. [25 points] Give the definition of a *polynomial time reduction* of a language L_1 to another language L_2.

11. [15 points] We write $\langle T \rangle$ for the binary encoding for any Turing machine, T. What is the *diagonal language*?

12. [20 points] What does it mean to say that a language can be generated in *canonical order*? What is the class of languages that can be so generated?

13. [20 points] What is the Church-Turing Thesis, and why is it important?

14. [30 points] Consider the following context-free grammar, and the GOTO/ACTION table for an LALR parser for that grammar. Show the sequence of configurations of the parser, the output sequence, and the parse tree determined by the parser, if the input string is `y/(x-y)/x`.

GRAMMAR

1. `S` → `S-S`
2. `S` → `S/S`
3. `S` → `(S)`
4. `S` → `x`
5. `S` → `y`

ACTION-GOTO TABLES

	`x`	`y`	`-`	`/`	`(`	`)`	**eof**	`S`
0.	s9	s10			s3			4
1.	s9	s10			s3			5
2.	s9	s10			s3			6
3.	s9	s10			s3			7
4.			s1	s2			**halt**	
5.			r1	s2		r1	r1	
6.			r2	r2		r2	r2	
7.			s1	s2		s8		
8.			r3	r3		r3	r3	
9.			r4	r4		r4	r4	
10.			r5	r5		r5	r5	

15. [30 points] Draw a transition-diagram (called "state diagram" in our textbook) for a Turing Machine that accepts $\{a^n b^n | n \geq 0\}$.

300.