15-453 Formal Languages, Automata, and Computation

Practice Midterm II

March 20, 2000

Name: ______________________________

Andrew ID: ______________________________

- This is a closed book exam; only 1 sheet of notes is permitted.
- Write your answer legibly in the space provided.
- You have 50 minutes for this exam.
- This exam consists of 2 questions worth 50 points each, plus one question for extra credit worth 30 points.

Problem 1	Problem 2	Total	Extra Credit
50	50	100	30

Problem 1 (50 pts)

a. (10 pts) Carefully state Rice's Theorem.

For the remaining questions, indicate if the language is decidable or undecidable and prove your result in each case. Use Rice's Theorem whenever applicable. If you give a correct alternative proof, you will receive partial credit. Also, if you correctly classify the language but do not give a correct proof, you will receive partial credit.

b. (10 pts) $\{\langle M, w\rangle \mid M \text{ accepts } w \in \{0,1\}^* \text{ and every prefix of } w\}$

c. (10 pts) $\{\langle M\rangle \mid M \text{ accepts all words } w \in \{0,1\}^* \text{ of even length}\}$

d. (10 pts) $\{\langle M\rangle \mid M$ decides the H_{TM}, the halting problem for Turing machines$\}$

e. (10 pts) $\{\langle M, w\rangle \mid M$, starting from $q_0 w$, overwrites a blank with a different symbol$\}$

Problem 2 (50 pts)

A co-nondeterministic Turing machine (Co-NTM) is a nondeterministic Turing machine which *accepts* an input w if all computations starting from the initial configuration q_0w reach the accepting state. It *rejects* w if all computations starting at q_0w terminate and it does not accept w.

A Co-NTM C *decides* a language L if it accepts every word $w \in L$ and rejects every $w \notin L$. We call a language L *co-decidable* if there is a co-NTM deciding L. In the questions below you may use the fact that Turing machines can simulate nondeterministic Turing machines.

a. (25 pts) Prove that if L is decidable then it is co-decidable.

b. (25 pts) Prove that if L is co-decidable then it is decidable.

Problem 3 (30 pts Extra Credit)

A Co-NTM C *recognizes* a language L if it accepts all words $w \in L$ and does not accept words $w \notin L$.

What can you say about the set of languages recognized by a Co-NTM?