

**Computer Science  
Comprehensive Examination  
Formal Languages  
Spring 2014**

1) (20 points) For each of the following indicate whether the specified language is (a) regular, (b) context-free but not regular, (c) recursive but not context-free, or (d) non-recursive (note that no proof is required).

a)  $\{0^i \mid i \geq 0\}$

b)  $\{0^i 1^i \mid i \geq 0\}$

c)  $\{0^i 1^i 2^i \mid i \geq 0\}$

d)  $\{x \mid x \text{ is a valid Turing Machine encoding}\}$

2) (20 points) Suppose  $L$  is a finite language, i.e., contains a finite number of strings over some finite alphabet. For each of the following, be sure to explain your answer.

a) Is  $L$  regular?

b) Is  $L$  context-free?

c) Is  $L$  recursive?

d) Is  $L$  recursively enumerable?

3) (15 points) Explain one technique for showing that a language is context-free. Stated another way, suppose you are given a language  $L$ . How do you show that  $L$  is context-free?

4) (15 points) State the pumping lemma for regular languages.

5) (15 points) Give a DFA or NFA that accepts the language  $0^*1^*(0+1)^*$ . Note that for this question you are not required to perform a formal conversion using any particular technique. Simply giving the DFA or NFA is sufficient.

6) (15 points) Prove that the recursive languages are closed with regard to set-difference.