

**Computer Science
Comprehensive Examination
Formal Languages
Spring 2004**

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 in any case).

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

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

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

d) $\{0^i 1^i 2^i 3^i \mid i \geq 0\}$

2) (15 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 guaranteed to be regular (yes or no)?

b) Is L guaranteed to be context-free (yes or no)?

c) Is L guaranteed to be recursive (yes or no)?

3) (20 points) Which one of the following models of computation most accurately reflects the computing power of an arbitrary computer program: DFA, NFA, PDA, or TM? Note that you should select exactly one model, and be sure to explain your answer.

4) (20 points) State the pumping lemma for context-free languages.

5) (25 points) Consider the regular expression $(0+1)^*11(0+1)^*$.

a) Give a DFA or NFA that accepts the language generated by the regular expression. 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.

b) Describe in English what the language generated by the regular expression is.