

**Formal Languages
Comprehensive Exam
Fall 2014**

1) (25 points)

(a) Give a DFA for the set of all strings of 0's and 1's where every 0 is immediately followed by the substring 111. Strings in the language include 11, 10111, 111, 0111011101111, etc.

(b) Give a context-free grammar for the set of all strings of 0's and 1's of the form $0^i 1^j 2^k$ where $i=k$ and $i, j, k \geq 0$.

(c) Now give a context-free grammar for the set of all strings of 0's and 1's of the form $0^i 1^j 2^k$ where $i > k$ and $i, j, k \geq 0$.

2) (25 points)

(a) State the pumping lemma for regular languages.

(b) Give an example of a DFA, an accepted string, and show how the string can be broken up based on the pumping lemma and the given DFA.

3) (25 points) Prove that the recursive languages are closed with respect to set difference. In other words, if L_1 and L_2 are recursive languages, then so is $L_1 - L_2$.

4) (25 points) Give a formal definition of a Turing Machine.