Comprehensive Examination
Formal Languages
Fall 2013

1) (20 points) Select an answer of true (T) or false (F) for each of the following.

Let L be a language that is context-free but not regular. Then L is recursive. T F

Let M be a multi-tape, non-deterministic Turing machine. Then there exists a single-tape, deterministic Turing machine M' such that L(M) = L(M'). T F

Let M be a non-deterministic PDA. Then there exists a deterministic PDA M' such that L(M) = L(M'). T F

Let L be a regular language. Then there exists a context-free grammar G such that L = L(G). T F

The pumping lemma for regular languages is used to prove that a language is regular. T F

Every precisely stated problem can be solved by an algorithm. T F

Every language containing an infinite number of strings is recursively enumerable. T F

Let L be a language that is not context-free, not recursive, not context-sensitive and not recursively enumerable. Then L must be regular. T F

Let L1 be a regular language, and let L2 be a recursive language. Then L1∩L2 is a recursively enumerable language. T F

Let G be a context-free grammar. Then there exists a regular grammar G' such that L(G) = L(G'). T F

2) (20 points) Indicate for each of the following 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) $\{0^i \mid i >= 0\}$

b) $\{0^i 1^i \mid i >= 0\}$

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

d) $\{0^i 1^i 2^j 3^j \mid i,j >= 0\}$

e) {w | w is a valid Turing machine encoding}

3) (20 points) Suppose L is a regular language. For each of the following, be sure to explain your answer.

a) Is L context-free?

b) Is L recursive?

c) Is L recursively enumerable?

d) Does there exist a Turing machine M such that L= L(M) and M always halts?

4) (20 points) Give a DFA or NFA that accepts the language (00+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.

5) (10 points) Suppose that L1, L2 and L3 are all recursively enumerable languages. Prove that $L1 \cup (L2 \cap L3)$ is a recursively enumerable language.

6) (10 points) State the Church-Turing Thesis.