CS381 Second Mid Term Friday, Nov. 4, 2005
Fall 2005 Olin 155 9:05-9:55 am

This is a 50-minute in class closed book exam. All questions are straightforward and you should have no trouble doing them. Please show all work and write legibly. Thank you.

1. Is the language $L = \{a^i b^j c^i d^j \mid i \geq 1, j \geq 1\}$ a context-free language? If yes give a Chomsky normal form context-free grammar for it. If not use the pumping lemma to prove that it is not a context-free language.

2. What is the specific class of languages defined by grammars in which each production is of one of the following forms:
   A variable goes to epsilon $A \to \varepsilon$
   A variable goes to a terminal $A \to a$
   A variable goes to a string consisting of two terminals $A \to ab$
   A variable goes to a string consisting of a terminal followed by a variable $A \to aB$
   A variable goes to a string consisting of two terminals followed by a variable. $A \to abB$

3. Let $L \subseteq \{a,b\}^*$ be a context-free language and let Final(L)$= \{y \mid \exists x \ xy \in L\}$. Prove that Final(L) is a context-free language or that Final(L) is not a context-free language using closure properties that preserve context-free languages.

4. Let $M = (Q, \Sigma, \Gamma, \delta, q_0, Z_0, F)$ be a multi-state pushdown automaton that accepts by empty stack. Let $M' = (Q', \Sigma', \Gamma', \delta', q_0', Z_0', F')$ be the equivalent one state pushdown automaton. Specify Γ' and δ' precisely.