

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. Give a context-free grammar for the set $\{a^i b^j \mid i \leq j \leq 2i\}$.
2. Prove or disprove that $L = \{a^n b^m c^n d^m \mid n \geq 1, m \geq 1\}$ is a context-free language.
3. Describe in English how to convert a many state pushdown automaton to a one state pushdown automaton.
4. Let L_1 be a context-free language. Suppose L_2 is obtained from L_1 by adding and deleting a finite number of strings. Is L_2 a context-free language? Justify your answer.