CSc 428 Formal Automata Final Exam Spring 2021

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May 21, 2021 @ 12PM – May 22, 2021 @ 11:59PM

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EXPLAIN ALL WORK!

1.
   a. Design a 1-tape TM M to decide the language $L = \{a^n b^m c^p \; such \; that \; n \geq 1, m \geq n, p \geq m\}$
   b. Trace M for each of the following strings: $abc, abbccc$
   c. What is the time complexity of this machine? Explain.
   d. Explain how a 3-tape TM would perform on this language.

2.
   a. Find a CFG for the language $L = \{a^n b^n \; such \; that \; n \geq 1\}$
   b. Convert your grammar to Chomsky Normal Form (CNF).
   c. Use the CYK algorithm to determine if $w = aabb$ lies in this language.

3. Try to construct a CFG that generates the language: $L = \{a^n b^n c^n \; such \; that \; n \geq 0\}$. Explain why none of your attempts succeed.

4. Let $L = \{a^i b^j c^k \; such \; that \; i > 0, i \leq j \leq k\}$. Give a context sensitive grammar that generates L.

5. Let G be the grammar:
   $S \rightarrow aSB \mid ab \mid SS$
   $A \rightarrow aA \mid \epsilon$
   $B \rightarrow bB \mid \epsilon$
   a. Give a leftmost derivation of $aaabb$.
   b. Give a rightmost derivation of $aaabb$.
   c. Show that G is ambiguous.
   d. Construct an unambiguous grammar equivalent to G.

6. How many symbols of look ahead would be required by an LL parser when parsing strings based on the following grammar? Design a corresponding parse table.
   $S \rightarrow xSy$
   $S \rightarrow xy$

7.
   a. State the pumping lemma for regular sets.
   b. Use this pumping lemma to prove that $\{a^n b^m \; such \; that \; n < m\}$ is not regular.

8. Explain concisely why you believe that a computer scientist should be conversant with theory.