

Name _____

CS 383
Exam 2
November 19, 2018

The exam has 6 questions. #1 is worth 20 points; the other five are worth 16 points each

1. Which of the following languages are context-free? Read the descriptions carefully. Write "CF" next to the languages that are context-free, "N" next to the ones that are not. No proofs are necessary.
 - a. $\{0^n 1^n 0^n \mid n \geq 0\}$
 - b. $\{0^n 1^n 1^n \mid n \geq 0\}$
 - c. $\{0^n 1^m 1^m 0^n \mid m, n \geq 0\}$
 - d. Strings of 0s and 1s with odd length that have 0 as the middle element, such as 1110101 or 000 or 101.
 - e. $\{vw \mid v \text{ is a string of 0s and 1s with length 3 or more and } w \text{ is the first 3 letters of } v\}$ For example, 01101011 is a string in this language.
 - f. $\{w0^n \mid w \text{ is a string of 0s and 1s and } n \text{ is the length of } w\}$ For example, 01110000 is a string in this language.
 - g. $\{uvw \mid u, v, w \text{ are all strings of 0s and 1s with the same length}\}$ For example, 011100 is a string in this language.

2. Construct a PDA that accepts by final state the language $\{0^n 1^m 0^m 1^n \mid m, n \geq 0\}$

3. Here is a grammar. Use this grammar to construct either a parse tree or a derivation (your choice; one is about as easy or hard as the other) for the string 001122:

$A \rightarrow 0A2 \mid BC$

$B \rightarrow 0B2 \mid C$

$C \rightarrow 1A1 \mid 1$

4. Convert the following grammar to Chomsky Normal Form:

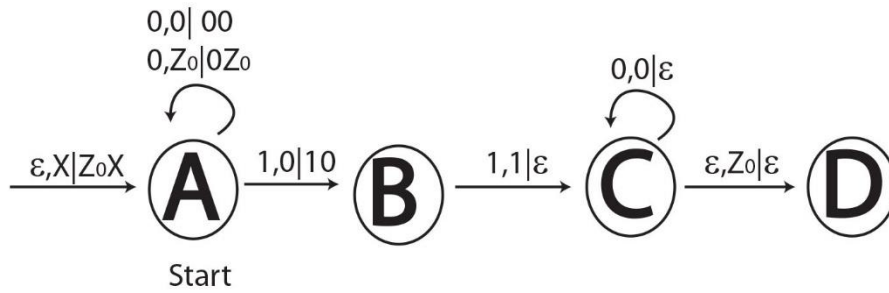
$A \rightarrow 0A2 \mid BC$

$B \rightarrow 0B2 \mid C$

$C \rightarrow 1A1 \mid 1$

5. Give a careful pumping lemma proof that $\{0^i 1^j 2^k \mid 0 < j, k < i\}$ is not a context free language. If you aren't clear about the language, it is the subset of $0^* 1^* 2^*$ where there are more 0s than either 1s or 2s.

6. In class we developed an algorithm by Noam Chomsky that constructs a grammar equivalent to a given PDA. Apply this algorithm to the following PDA and give the derivation in this grammar of the string 001100. Note that the PDA accepts by empty stack.



You can use this page as extra space for any problem.

Please write and sign the Honor Pledge when you have finished the exam. If you didn't take the exam with the rest of the class also write your starting and stopping times.