

University of Nevada, Las Vegas Computer Science 456/656 Fall 2018

Assignment 7: Due November 28, 2018

Name: \_\_\_\_\_

You are permitted to work in groups, get help from others, read books, and use the internet. But the handwriting on this document must be your own. You may attach extra sheets using a stapler, not a paper clip.

To work some of these problems, you may need to do some research, meaning reading the textbook or searching the internet.

1. In this problem, “pumping length” means a  $p$  given by the pumping lemma for context-free languages. Let  $L$  be the language  $\{a^nbc^n\}$  What is the minimum pumping length of  $L$ ?

2. Give the definitions of the four types of grammars in the Chomsky hierarchy. (Don’t be long-winded. You can get full credit for a very short answer.)

3. The *Bach language* is the set of all strings over a three symbol alphabet which have equal numbers of each symbol. For example, *aaabbbccc* and *abccbaca* are members of the Bach language. Where does the Bach language fit in the Chomsky hierarchy?

4. Let  $L$  be the language of all strings over the unary alphabet  $\{1\}$  whose lengths are powers of 2. That is,  $L = \{1, 11, 1111, 11111111, \dots\}$ . Give an unrestricted grammar, also called a general grammar, which generates  $L$ .

5. I proved that there is a function  $f$  which is eventually greater than any computable function. A student said,

”But Dr. Larmore, didn’t you just give a computation of  $f$ ? Thus  $f$  is computable, which implies that  $f$  is eventually greater than itself, contradiction.”

This does appear to be a contradiction, doesn’t it! Explain why there is no contradiction.

6. Let PRIMALITY be the language consisting of all binary strings which are binary numerals for prime numbers. Prove that PRIMALITY is co- $\mathcal{NP}$ .

7. Assuming that Knapsack is  $\mathcal{NP}$  complete, give a proof that Partition is  $\mathcal{NP}$  complete by giving a polynomial time reduction from Knapsack to Partition.