University of Nevada, Las Vegas Computer Science 456/656 Fall 2023
Assignment 3: Due Friday September 22, 2023, 11:59 PM

Name: _____

You are permitted to work in groups, get help from others, read books, and use the internet. You will receive a message from the graduage assistant, Sepideh Farivar, telling you how to turn in the assignment.

1. True or False, write T or F. If the answer is unknown to science at this time, write O, for Open.

   (a) _____ Every regular language is a context-free language.

   (b) _____ The problem of whether two context-free grammars are equivalent is undecidable.

   (c) _____ If a language L is accepted by an NFA with n states, then L is generated by a grammar with at most n variables. (Be prepared to search for the answer: I didn't give it in class.)

   (d) _____ $\mathcal{P} = \mathcal{NP}$.

2. For each of the grammars given below, each variable symbol is a capital Roman letter, each terminal symbol is a lower case Roman letter, and the start symbol is S.

   (a) Which of these grammars generates $\{a^n b^n : n \geq 0\}$?

   (b) Which of these grammars generates
   $\{a^n b^m : n, m \geq 0, n \neq m\}$?

   (c) Which two of these grammars are equivalent?

   (d) Which of these grammars is ambiguous?

   Grammar G_1:
   $S \rightarrow aSb$
   $S \rightarrow \lambda$

   Grammar G_2:
   $S \rightarrow aSb$
   $S \rightarrow aA$
   $A \rightarrow aA$
   $A \rightarrow \lambda$
   $S \rightarrow bB$
   $B \rightarrow bB$
   $B \rightarrow \lambda$

   Grammar G_3:
   $S \rightarrow aSbS$
   $S \rightarrow \lambda$

   Grammar G_4:
 $S \rightarrow aSb$
   $S \rightarrow SS$
   $S \rightarrow \lambda$

3. I was wrong on Monday: I wrote the three labels each transition in the wrong order. The correct order is "read/pop/push." Commas can be used instead of slashes.

   When we push two or more symbols, the topmost one is on the left of the string. For example: if the label on the transition is $a/z/az$, then z is popped, a is read, and az is pushed, but that means z is pushed first, then a is pushed on top of it. You must pop one symbol. You can read either one or zero symbols. You can push any number of symbols.

   What is the language accepted by the DPDA illustrated below?
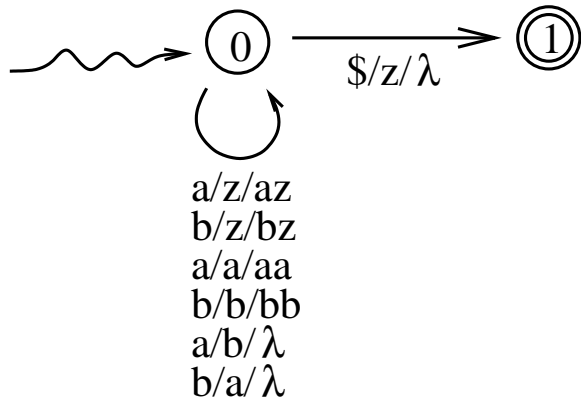
4. Design a DPDA which accepts the Dyck language. For ease of grading, use the version where the terminal symbols are a and b, not parentheses.