

**Computer Science 423**  
**Fall 2024**  
**Homework 7**  
**My name and section**

**Due: beginning of class, Thursday, 10/31/2024**

**Points: 50**

Answer the following questions and submit typeset solutions by the due date. As stated on the syllabus, any collaborators or outside sources must be listed under the corresponding problem. Further, your final submission must be completely your own work.

1. [3 points each] For each statement below, state whether it is True or False. No explanation necessary.
  - (a) We can construct a PDA for the language  $L = \{a^{2n}b^n \mid n = 1, 2, 3, \dots\}$  by first constructing a FA for  $L$ , and then converting the FA into a PDA for  $L$ .
  - (b) Every CFG has an equivalent deterministic PDA.
  - (c) Let  $P$  be a PDA with the property that, when reading a string, it can never put more than three total symbols on the stack.  $L(P)$  must therefore be regular.
  - (d) Converting any CFG to Chomsky normal form will ensure that it is unambiguous.
  - (e) If a PDA accepts language  $L$ , but does not require the stack to do so,  $L$  can be generated by a regular expression.

Collaborators:

2. [5 points] Show that the following grammar is ambiguous.

$$\begin{aligned} S &\rightarrow aB \mid bA \\ A &\rightarrow aS \mid bAA \mid a \\ B &\rightarrow bS \mid aBB \mid b \end{aligned}$$

Collaborators:

3. [7 points] Convert the following CFG into an equivalent CFG in Chomsky normal form. Show (and number) each of the four steps, as in the class slides.

$$\begin{aligned} S &\rightarrow XY \\ X &\rightarrow abb \mid aXb \mid \epsilon \\ Y &\rightarrow c \mid cY \end{aligned}$$

Collaborators:

4. [9 points] Convert the following CFG into an equivalent CFG in Chomsky normal form. Show (and number) each of the four steps, as in the class slides.

$$\begin{aligned} S &\rightarrow T \mid TST \mid \epsilon \\ T &\rightarrow 10 \mid \epsilon \end{aligned}$$

Collaborators:

5. [14 points] Provide a PDA that recognizes language  $L_1$ . Show both a state diagram and the 6-tuple specification (including a transition table).

$$L_1 = \{a^i b^j c^k \mid i, j, k \geq 0 \text{ and } i + j = k\}$$

Collaborators: