

# FLA (Fall 2023) – Assignment 2

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

Grade: \_\_\_\_\_ ID: \_\_\_\_\_

**Due: Nov. 2, 2023**

## Problem 1

Give context free grammars that generate the following languages, and give a brief description of the functionality of each variable in your grammars (in natural language) if necessary.

- a.  $\{a^i b^j \mid i, j \geq 0 \wedge 3i = j\}$
- b.  $\{w \in \{a, b\}^* \mid \exists w_1, w_2 \in \{a, b\}^*, w = w_1 w_2 \wedge w_1 = {w_1}^R \wedge w_2 = {w_2}^R\}$
- c.  $\{a^i b^j \mid i, j \geq 0 \wedge i \neq j\}$

## Problem 2

For each of the following languages, please provide nondeterministic PDAs **accepting them by final states.**

a.  $\{a^i b^j \mid i, j \geq 0 \wedge 3i = j\}$

b.  $\{w \in \{a, b\}^* \mid \exists w_1, w_2 \in \{a, b\}^*, w = w_1 w_2 \wedge w_1 = {w_1}^R \wedge w_2 = {w_2}^R\}$

**Solution.**

## Problem 3

Consider the following context free grammar G:

$$S \rightarrow bAA \mid a$$

$$A \rightarrow aS \mid bS \mid b$$

- a. For the string  $bbbaabaa$ , give one possible parse tree and rightmost derivation according to  $G$ .
- b. Provide a nondeterministic PDA  $P$  that accepts the language  $L(G)$  by empty stack.

**Solution.**

## Problem 4

Begin with the grammar:

$$S \rightarrow abAB \mid C$$

$$A \rightarrow bAB \mid \epsilon$$

$$B \rightarrow BAa \mid A \mid \epsilon$$

$$C \rightarrow ab \mid ba$$

1. Eliminate  $\epsilon$ -productions.
2. Eliminate any unit productions in the resulting grammar of (1).
3. Eliminate any useless symbols in the resulting grammar of (2).
4. Put the resulting grammar of (3) into Chomsky normal form.