

# Homework 5

## Part I

For each of the languages below, construct a context free grammar (CFG) in JFLAP that generates the given language.

In addition, for each language, create two text files, one that contains 5 strings (one string per line) that are in the language and one that contains 5 strings (one string per line) that are *not* in the language. Name the files according to the problem number: 1.jff for the JFLAP file, 1-in.txt for the list of 5 strings in the language, and 1-out.txt for the list of 5 strings not in the language and similarly for the other problems, 2.jff, 2-in.txt, 2-out.txt, etc.

In order to test if strings are in the language or not, first convert the CFG to Chomsky normal form (CNF) by selecting “Transform Grammar” from the “Convert” menu and selecting “Do all” and then “Proceed” until the CFG is in CNF and then click “Export.” You can test the resulting CFG by selecting “Multiple CYK Parse” from the “Input” menu. **If you do not first convert to CNF, the CYK algorithm will fail and JFLAP will give you incorrect results.** The grammars you turn in should *not* be the ones you converted to CNF.

**Problem 1 [10 points]**  $A = \{w \mid w \in \{a, b\}^* \text{ has more } a\text{'s than } b\text{'s}\}.$

**Problem 2 [10 points]**  $B = \{w\#x \mid w, x \in \{a, b\}^* \text{ and } w^R \text{ is a substring of } x\}.$  Remember,  $w^R$  is a substring of  $x$  if there are strings  $y, z \in \{a, b\}^*$  such that  $x = yw^Rz$ .

**Problem 3 [10 points]**  $C = \{a^m b^n c^k \mid m, n > 0 \text{ and } k = m + n\}.$

## Part II

For each of the languages  $A$ ,  $B$ , and  $C$  above, give a push down automaton in JFLAP that recognizes the language. **Do not use JFLAP to convert your CFGs to PDAs or vice versa. Do not follow the procedures given in the book to convert between PDAs and CFGs. Just construct the PDAs from scratch.**

**Problem 4 [10 points]** Construct a PDA that recognizes language  $A$ .

**Problem 5 [10 points]** Construct a PDA that recognizes language  $B$ .

**Problem 6 [10 points]** Construct a PDA that recognizes language  $C$ .